Perceived Attributes of Disposal Technologies among Residents living near the U.S. Army's Chemical Weapons Stockpile Sites: A Hierarchical Linear Model

Bryan L. Williams, PhD
EBR Director and Assistant Professor of Epidemiology
Environment, Behavior, and Risk Research Laboratory (EBR Lab)
University of Arizona

Alex Vallei, MA
Environment, Behavior, and Risk Research Laboratory
University of Arizona

Hoi K. Suen, EdD
Professor of Educational Psychology
The Pennsylvania State University

Sarah E. Rzasa, BS
Psychometric Consultant
The Pennsylvania State University

Sylvia Brown, MPH
Senior Research Specialist
Environment, Behavior and Risk Research Laboratory
University of Arizona

All correspondence should be directed to:
Bryan L. Williams, PhD
University of Arizona
Arizona Prevention Center (EBR Lab)
Campus PO Box 245163
Tucson, AZ 85724
(520) 626-3406
bryanw@u.arizona.edu

Table Of Contents

Executive Summary

University of Arizona researchers conducted a cross-sectional descriptive and analytical study across ten states. Primary data were obtained through a random digit dialing population survey. Site specific survey teams systematically identified and prioritized objectives for the population survey. The study sample consisted of 8,315 residents living within emergency response zones surrounding the U.S. Army's Chemical Weapons Stockpile sites. The *refusal rate after consent* was 21% across all sites.

The study was designed to identify the perceptual origins of environmental technology acceptance or rejection among individuals who are potentially impacted by the use of such technology. To this end, the following three research questions were examined in this study: (1) To what extent do respondents attribute specific diffusion characteristics with either the incineration or neutralization disposal technology? (2) To what extent do individual factors influence a respondent's *attributions toward the technologies?* (3) To what extent do community factors influence a respondent's *attributions toward the technologies?*

The findings suggest that residents appear to perceive clear differences between the desirable characteristics of the two technologies. In a relative comparison, the majority of positive technological attributes were more commonly associated with incineration. Five of the eight sites were significantly more predisposed toward incineration than neutralization. Positive perceptions toward incineration were associated with individuals who trust the Army, who perceive that the media have made them more trusting of weapons disposal activities, who are ready to participate, and who are male. Unlike incineration, there was insufficient proof that individual factors influence variations in perceptions toward neutralization. Site level variables failed to predict either perceptions toward incineration or neutralization.

Background

Communities frequently oppose the placement or use of environmental technologies (i.e., incinerators). Reasons for public opposition vary. Environmental managers commonly assume that public opposition to technology is due simply to the public's technological ignorance, thus ignoring the emotional origins of such resistance. The assumption that technology is neutral with respect to individual values and perceptions is false. Technological decisions affect people. Hence, people are understandably concerned that these decisions be made with care and with respect for their individual values. Ignoring the value-laden nature of technology typically provokes the public into disputing technological decisions, particularly in the environmental arena. However, researchers know little about the determinants of environmental technology acceptance among individuals.

Some argue that the public's technological ignorance provides sufficient grounds for excluding them from technical decision-making (Cohen, 1995; Lidskog, 1997). Others contend that human emotion keeps people from being detached from environmental issues and making rational decisions (Kweit and Kweit, 1987). However, we do not know the extent to which technical knowledge or, the lack thereof influences public acceptance or opposition to technical decisions. It is likely that knowledge alone has little affect on the public's positions on environmental technology. Several studies have indicated that attitudes or human perceptions represent a stronger determinant of technological acceptance than does human cognition (Dearing et al., 1996; Ferrence, 1996; Oldenburg, Hardcastle, and Kok, 1997; Rogers, 1995a; Stiff, 1994). However, few studies have examined the public's perceptions toward specific environmental technologies and the impact of such perceptions on technological concurrence.

The purpose of this study was to delineate perceptions toward disposal technologies among residents living near the U.S. Army's Chemical Weapons Stockpile sites. The study was designed to identify the perceptual origins of environmental technology acceptance or rejection among individuals who are potentially impacted by the use of such technology. To this end, the following three research questions were examined in this study: (1) To what extent do respondents attribute <u>specific diffusion characteristics</u> with either the incineration or neutralization disposal technology? (2) To what extent do <u>individual factors</u> influence a respondent's *attributions toward the technologies?* (3) To what extent do <u>community factors</u> influence a respondent's *attributions toward the technologies?*

Literature Review

On a basic level, environmental technologies symbolize innovations or "new ideas" for most of the lay public. Public acceptance of innovations requires the public to be comfortable with the various aspects of the innovation. The literature suggests that the diffusion and subsequent adoption of innovations across populations is inherently a predictable and observable process. The specific characteristics of the innovation itself dramatically influence the rate of technological acceptance across a population. This process has strong theoretical underpinnings. The following sections provide theoretical explanations for acceptance for technological innovations.

Public Acceptance of Technology: Diffusion of Innovations Theory

<u>Definitions:</u> *Diffusion* is a process in which members of a social system are able over a period of time to communicate an innovation or a new idea. Such communication is important to the adoption of an innovation. *Adoption* refers to the actual utilization or acceptance of a given innovation. In terms of environmental technologies, individuals do not personally utilize such technologies. In this context, adoption refers to the acceptance or lack of opposition to a given environmental technology. Thus, both diffusion and adoption will be discussed from a Diffusion of Innovations perspective so that a strong foundation is developed for the purpose of explaining how the public accepts different environmental technologies.

<u>Diffusion</u>: The diffusion process is facilitated through the use of specific communication channels. This communication involves the dissemination of new ideas and may be defined as a process in which individuals develop a mutual understanding through the sharing of information and knowledge. The newness of the idea or innovation in the message provides the diffusion process with its special character. Thus, an innovation may be considered as an idea, practice, technique, object or some product that is perceived as new by an individual or another entity (e.g., organization) that participates in the adoption of the innovation (Dearing et al., 1996; Ferrence, 1996). Diffusion occurs through a combination of the need for people to (a) reduce uncertainty when they are confronted with new information and to (b) deal with social and peer pressure based on their acknowledgment of others who have adopted the innovation (Dearing et al., 1996). A technological innovation provides uncertainty for the potential adopter. Thus, when an individual becomes cognizant of an innovation or new technology, he or she asks questions, such as: How does the innovation work? How much does it cost? Who pays for it? Where can it be obtained? Is it safe and/or effective? (Rogers, 1995b). These questions facilitate a reduction of uncertainty in the potential adopter. An important component of the Diffusion of Innovations process is the identification of the different adoption categories.

<u>Categories of Adopters:</u> This classification scheme is based on a continuum of innovativeness. Innovativeness is concerned with how early an individual or any other unit of adoption is, with respect to adopting or accepting new ideas, than other members implicated in the same social system. Rogers (1995a) has identified five categories of adopters based on the innovativeness concept. They are innovators, early adopters, early majority adopters, late majority adopters, and laggards. <u>Innovators</u> are individuals who are venturesome—they have a desire for the rash, the daring, and the risky. They have an intrinsic need to delve into ideas that are outside the realm of a system's boundaries. Furthermore, innovators interact with individuals outside of their social networks, and their social networks tend to be comprised of other innovators. Prerequisites for an innovator include the ability to deal with a tremendous amount of uncertainty at the time of adoption of an innovation and the ability to comprehend complex knowledge. <u>Early adopters</u> work within a system's boundaries. They are the individuals potential adopters consult with for advice and information concerning an innovation, and they serve as a role model for other individuals who are implicated in the early adopter's social system. In addition, the early adopter is able to decrease uncertainty about an innovation by adopting the innovation. Upon adoption of the innovation, the early adopter is able to convey a subjective evaluation of the innovation through interpersonal networks. Early majority adopters are not considered the opinion leaders in a system, but they do adopt new ideas just ahead of the average member of a system. Early majority adopters represent an important conduit in the diffusion process because of the link they provide between very early and the relatively late adopters—they provide interconnectedness in the system's interpersonal networks. Late majority adopters accept or adopt new ideas just after the average member of a system. These individuals approach new ideas with a high degree of skepticism, and do not adopt until almost all members of a system have done so, and they do not adopt a new idea until it is practically devoid of uncertainty. Finally, laggards are individuals who refrain from adopting an innovation until all individuals in a system have adopted. Opinion leadership is almost nonexistent among this group and their method for adopting an innovation is based on what has occurred in the past (Rogers, 1995a). In conjunction with understanding the relevance of the adopter categories to the diffusion process, it is also important to understand the specific attributes a technological innovation may have for the purpose of developing a clear conceptualization of the adoption process. According to Rogers (1995a), the perceived attributes or characteristics of an innovation facilitate or hinder the rate of adoption of the innovation or the relative speed with which individuals adopt or accept an innovation in a social system.

Technological Attributes: An innovation has certain characteristics or attributes, based on individuals' perceptions, that determine the speed or rate of adoption and extent of diffusion (Oldenburg et al., 1997; Rogers, 1995a). In short, people tend to associate specific traits to an innovation. Like any other technology, environmental technologies possess certain inherent characteristics that potentially influence their public acceptance. For example, incineration often conjures up negative mental images of industrial pollutants being released into the air through smokestacks.

It is the perception of these traits that is important to the adoption process. Perceptions toward the traits of a given technology may have no actual basis in fact but are crucial to the adoption process. Five essential perceived characteristics have been found to influence the rate of adoption of an innovation. Relative advantage is concerned with whether the innovation is better or superior to the existing practice that it is replacing. Compatibility is the degree to which an innovation dovetails with the values, past experiences, beliefs, and needs of potential adopters. Complexity focuses on whether the innovation or new idea is perceived as easy to use. Trialability is concerned with whether an innovation can be tested or experimented with by an individual on a limited basis. Observability is the degree to which the results of an innovation are observable (i.e., seen), and easily measurable (Ferrence, 1996; Oldenburg et al., 1997; Rogers, 1995a, 1995b). According to Rogers (1995a), innovations that individuals perceive as having the attributes of greater relative advantage, compatibility, trialability, observability, and less complexity will be adopted more rapidly than other innovations. In addition, the basic rationale behind each of these attributes is that not all innovations are considered equivalent units of analysis. For example, a consumer innovation such as a mobile phone or VCR may only require a few years before it achieves widespread adoption. On the other hand, other novel ideas such as the use of seat belts may take decades before they achieve widespread use or adoption (Rogers, 1995b). There is a dearth of literature concerning the perceived attributes of environmental technologies.

In fact, research on the public acceptance of environmental technologies has not been conducted employing a Diffusion of Innovations framework.

Understanding the diffusion and adoption process is crucial to providing an explanatory framework for determining why certain innovations are successful in being adopted by a public and why certain innovations fail to be adopted by this same public. First, a theoretical explanation for diffusion and adoption of an innovation will be presented in the context of a theoretical framework comprised of three different perspectives. Second, the relevance of both personal and societal characteristics will be delineated as they relate to the diffusion and innovation process. Finally, knowledge will be discussed as it relates to whether or not an individual is prepared to accept an innovation.

Theoretical Perspectives on Diffusion and Adoption

Diffusion based theories may be categorized in three different ways. Ferrence (1996) investigated the diffusion and adoption of tobacco by providing a theoretical framework for understanding Diffusion of Innovations Theory in the context of health problems and interventions. His framework relies on three distinct perspectives: (a) rational/economic, (b) behavioral, and (c) systems perspective. These three perspectives comprise a diffusion model, which may be useful in examining different aspects of the diffusion and adoption process for tobacco use (Ferrence, 1996). The rational/economic perspective is usually applied to explain the diffusion of new products or processes with respect to their economic and structural dimensions. The behavioral perspective emphasizes the communication aspect of diffusion. Moreover, the systems perspective focuses on entrepreneurial factors, which may influence adoption behavior. The application of each of these perspectives to diffusion theory will be delineated below.

The <u>rational/economic perspective</u> incorporates both a structural and an economic component for understanding diffusion of tobacco. For example, competition within the tobacco industry represents a structural component that makes keeps tobacco prices lower and encourages aggressive marketing, which in turn facilitates diffusion of the product. Additionally, the willingness of government to allow the tobacco industry to regulate itself instead also represents a “structural” catalyst for the speedy diffusion of tobacco in our society. The diffusion of environmental technologies is potentially influenced by a number of structural factors. For example, the relationship between the federal government and special interest groups can have a tremendous impact on the siting of, public acceptance of, or legal challenges to a given remediation technology. Contentious relationships between activists groups and government can delay the employment of environmental technologies for years.

Economic factors also greatly influence diffusion of technology at both the organizational and the individual levels (Ferrence, 1996). Economic factors influence a given product’s supply, pricing, profit margins, and demand. On the individual level, one’s financial wherewithal may also affect consumption or use of that product. On the organizational level, profit incentives may effect the length to which groups will go to sell a product or technology.

For example, the tobacco industry aggressively pursues consumers at all costs because its financial rewards from such efforts have been great and the risks have been minimal. Economic incentives also influence the public acceptance of environmental technologies. For example, one study found that many citizens were willing to allow the shipment and storage of nuclear materials within their community so long as it brought jobs to their community (Williams, Brown, and Greenberg, 1999).

The behavioral perspective includes both the communications and the champion component (Ferrence, 1996). The communications component is based on the premise that communication encroaches on the rate of diffusion of any innovation. This communication could be interpersonal, media-related, or expressed through a different modality. Furthermore, the speed with which an innovation is adopted (i.e., its rate of adoption) is also related to its source, the characteristics or attributes of the innovation, the channels of communication that are available, and the characteristics of the adopters. The higher the source credibility, the greater the possibility of adoption (Ferrence, 1996). Credibility is the degree to which a source is perceived as competent (i.e., has expertise), and is trustworthy (Stiff, 1994). For example, when individuals acquired information about a medical innovation from a source that was credible, they are more inclined to be persuaded to adopt the innovation or new idea (Rogers, 1995b).

The champion component focuses on the importance of those individuals in an organization that have the greatest access to sources of communication, and with the greatest orientation or links to individuals outside of their group. This model specifically focuses on the role of the innovator plays in an organization. (Ferrence, 1996). Thus, champions are leaders in the adoption of innovations. Individuals or groups who promote collaboration or communication between “technology providers” and “technology users” are called “change agents.” (Glanz, Lewis, and Rimer, 1990). Changes agents do not have to be independent third parties, they can be members of either of the two aforementioned groups (Glanz, Lewis, and Rimer, 1990). For example, the Army could potentially act as a “change agent” in the diffusion of disposal technologies. The public may be more likely to identify the Army as a change agent if the public trusts and identifies with the Army.

Finally, the systems perspective incorporates both a marketing and contextual dimension. The marketing model focuses on entrepreneurial factors that influence innovation adoption. For example, the marketing dimension is represented in the number of outlets, pricing policy, promotional activities aimed at a specific group, and market segmentation—all of these factors affect innovation adoption. The contextual dimension is based on inter-organizational relationships and government policies. Using tobacco as an example, smugglers exported Canadian cigarettes back into Canada from the U.S. because the U.S. had much lower cigarette taxes. The cigarettes that were exported legally to the U.S. from Canada, and then smuggled back into Canada were sold at substantially lower prices than the cigarettes sold legally in Canada (Ferrence, 1996). In this case, adoption (i.e., tobacco consumption) was facilitated directly and indirectly by government policies and the inter-organizational relationships. Lower U.S. taxes (i.e., relative advantage) and possible governmental indifference toward smuggling facilitated tobacco sales and consumption in Canada (Ferrence, 1996). Governmental systems can also influence the extent to which the public is involved in environmental technology decisions. In the U.S., citizen participation in environmental decisions is often mandated (Desario and Langton, 1987). Citizen participation is not necessarily advocated in less democratic systems. In the U.S., such participation can have a direct effect on the rate at which such decisions are implemented.

The Importance of Individual and Societal Characteristics in Technological Adoption

Personal Characteristics: Personal characteristics play an important role in the acceptance of innovations or technologies. Ferrence (1996) determined that individuals, who adopt at different phases of the diffusion process, also have a tendency to differ in specific ways related to age, sex, residence, socioeconomic status, and level of access to communications. It was concluded that males who are of a higher socioeconomic status, especially with a higher education, with status aspirations, with greater access to a variety of sources of communication, and who also reside in large urban communities are more inclined to be innovators or early adopters. For example, early adopters are individuals who would be willing to try new tobacco brands or products when they are available in retail outlets. In addition, with more specialized products such as nicotine replacement therapy, women and the elderly tend to be early adopters because they visit physicians most often (Ferrence, 1996). In addition, according to Ferrence (1996), emphasizing the determinants of tobacco uptake, adolescents are affected by their peers, their family, the availability of tobacco in neighborhood outlets, and pro-smoking advertising of new and existing tobacco products. These determinants represent a few of the critical factors that affected the rate and extent of adoption.

Parcel et al. (1995) also found that ethnic composition was predictive of adoption. A study conducted by Jeffres and Atkin (1996) used diffusion theory to provide the framework for understanding public interest in ISDN (Integrated Systems Digital Networks) by casting this technology as an innovation. Contrary to the previous evidence, Jeffres and Atkin (1996) found a diminished role for demographics as it related to explaining public interest in using or adopting the ISDN innovation. They found that better educated and higher income households were negatively related to using or adopting technology for consumer purposes. According to the authors, this was found to be suggestive of a leveling of differences among technology adopters. Reagan (1991) and Sparkes and Kang (1986) also suggested in their respective studies that a leveling of differences among technology adopters had occurred. For example, Sparkes and Kang (1986) found no demographic differences in age, household size, household income, and level of education of their samples versus census information for the geographic area in which they conducted their study. Thus, demographics did not play a predictive role in the adoption of cable television in this study. Based on the conflicting evidence, the controversy over global demographic predictors warrants further exploration.

Societal Characteristics: Societal factors are equally important in the diffusion process. Parcel et al. (1995) investigated cigarette smoking by conducting a diffusion of innovations study to ascertain the intervention strategies that result in an increase in the adoption of an innovative tobacco prevention program (Smart Choices Program). Specifically, Parcel et al. (1995) determined whether organizational (e.g., size, expenditure per pupil, percent college bound, percent minority), school and district level administrative, and middle-school teacher characteristics were considered to be indicative of the potential adopters of the Smart Choices Program. Teachers and administrators felt that the Smart Choices Program had a distinct relative advantage (i.e. it was perceived as better), than the existing prevention program, and this was found to be predictive of the subsequent adoption of the Smart Choices Program by these same officials. Parcel et al. (1995) concluded that any attempt to influence the adoption process should include those individuals (i.e., teachers) who were responsible for administering and implementing prevention programs, and not to focus solely on school and district level administrators to facilitate the adoption of the innovation. Thus, it is important to involve individuals who are responsible for carrying out the adoption of the innovation because determining how favorable teachers were about the program played an important role in adoption of this innovative tobacco prevention program.

In another school-based study, Paulussen, Kok, Schaalma, and Parcel (1995) evaluated the acceptability of AIDS curricula among Dutch secondary school teachers. In this study, Paulussen et al. (1995) also acknowledged the importance of teachers or the individuals who play a vital role in the adoption of innovative AIDS curricula or in the diffusion of an innovation. Furthermore, subjective norms (beliefs about whether significant others think a person should or should not engage in a particular behavior) (Eagly and Chaiken, 1993), and instrumentality (when an innovation provides clear procedural instructions or how-to specifications) provided an explanation for the variability in teachers' adoption of AIDS curricula. And, the importance of subjective norms in promoting diffusion is related to the general finding by Paulussen et al. (1995), that knowledge acquisition or adoption of various AIDS curricula was contingent upon the diffusion networks that existed among the schools. Supporting this contention, Michaelson (1993) believed that the diffusion of an innovation is dependent upon the distribution of social ties in a community, and the different roles individuals assume in a social network. Shaperman and Backer (1995) found that the development of networks of potential users of innovations early in the research process facilitated the control over the research innovation. They also found that networks provided an impetus for the completion of the research endeavor because network members had a stake in the success of the research, and were receptive to the adoption of the innovation as an outcome or manifestation of the research. It is important to comprehend how diffusion occurs among specific technologies.

The Importance of Knowledge in Technological Adoption

Individual knowledge appears to have some influence on one's readiness to employ or accept a given innovation. Attewell (1992) found that as barriers to knowledge about a technology were reduced or eliminated, acceleration of the diffusion process occurred and the innovation or new technology was transformed from initially being considered as a general service for the organization to a major provision or crucial component of the organization. This study investigated the diffusion of business computing. The author observed that the computer revolution was facilitated by the removal of the burden of knowledge acquisition as a responsibility of the potential computer user—this allowed a relatively complex technology to diffuse rapidly in organizations, which did not have the requisite expertise in computing knowledge. Attewell (1992) concluded that uncertainty and complexity in business computing were reduced through the use of icon interfaces and menus, help screens, query-by example communications, but this reduction in uncertainty engendered complexity in hardware and software. That is, as uncertainty and complexity were reduced from a computer user's perspective, this created a concomitant increase in the knowledge burdens in hardware and software design. Thus, it was concluded that reducing uncertainty and complexity in one area would increase uncertainty and complexity in another area.

Similar to Attewell (1992) who focused on the importance of knowledge in the diffusion of an innovation, Shaperman and Backer (1995) also observed the importance of knowledge, but in Academic Medical Centers (AMCs). Specifically, they suggested numerous ways for AMCs to increase their effectiveness in the employment of knowledge utilization strategies to facilitate the adoption of various medical innovations. Shaperman and Backer (1995) investigated facilitators and barriers to knowledge utilization with AMCs. Examples of knowledge utilization in the context of AMCs included the following: (a) hosting meetings for physicians with speakers to discuss an innovation; (b) writing and distributing position papers on the innovation; (c) publishing an annual report delineating research progress; (d) educating the public about the innovation via mass media; and (e) teaching patients about the innovation using videotapes and social support groups. One finding from this study was that AMCs could not rely solely on publications in scholarly journals and presentations at meetings for the purpose of having their medical innovations adopted by others. It was concluded that AMCs must provide incentives for activities beyond publication or dissemination. AMCs must use opinion leaders, idea champions, and individuals who are willing to discuss their previous experiences in using the innovation (Shaperman and Backer, 1995). Finally, barriers to adoption and utilization of innovations were found to be due to an emphasis on tradition or prior experience, minimization of the importance of knowledge utilization, reduction in incentives, and an inability to understand the knowledge utilization process (Shaperman and Backer, 1995).

Greer (1995) also investigated the diffusion of technological innovations in the medical context. In his assessment of medical innovations, he stipulated that new medical technologies or innovations including many practice guidelines were not considered to be coherent products. In fact, they were believed to be in a perpetual state of flux, and were found to be developing as they diffused. Related to the previous studies on knowledge innovations dealing with technological innovations was a study conducted by Ganesh, Kumar, and Subramaniam (1997) on durable products. The study focused on consumer learning as part of the explanatory framework for understanding the adoption of new technologies in different markets. The purpose of this study was to develop an insight into the diffusion patterns across cultures so that a determination could be made of the timing and order-of-entry decisions that are best suited for a company, given resource constraints and the nature of the product or innovation (Ganesh et al., 1997).

Ganesh et al. (1997) investigated more common technological innovations and the importance that consumer learning may have on the adoption of these innovations in foreign markets. These researchers were interested in studying the diffusion of four consumer technological innovations (VCRs, home computers, microwave ovens, and cellular phones) across an average of 15 European countries. Specifically, they wanted to know what effect consumers in European lead markets have on consumers or potential adopters in lag markets, and what effect factors such as consumer learning, taking place between the lead (where the innovation is first introduced) and lag country, may have on the adoption of the four technological innovations. Furthermore, the authors noted that identification of these factors might provide assistance to managers in both market selection and order-of-entry decisions with respect to technological innovations. Six factors were hypothesized to influence the learning process by Ganesh et al. (1997): geographical proximity or similarity, cultural similarity, economic similarity, time lag, type of innovation, and technical standard.

Each of these factors was based on the following definitions. Geographical proximity or similarity was defined as the distance between capital cities of the lag and lead countries. Cultural similarity was based on four dimensions that represented the basic value orientations that support national differences—as they relate to managerial practices, organizational patterns, and decision making. The four dimensions were: (a) power distance, (b) masculinity/femininity, (c) uncertainty avoidance, and (d) individualism. Economic similarity was based on universal economic indicators such as gross domestic product per capita, literacy rate, urbanization level, unemployment rate, level of industrialization, etc. Time lag was based on the difference between product introduction in the lead country, and consumers learning about the product in the lag country. Type of innovation is based on the difference between continuous and discontinuous innovations, which are defined as follows: continuous innovations are innovations in which the consumer knows something about the innovation's core benefit, and discontinuous innovations are innovations in which the consumer does not know very much about the innovation's core benefit. For example, a home computer is considered to be a continuous innovation because it possesses a majority of the same features found with earlier versions of this specific product or innovation. This may also include new features that imbue this product or innovation with additional value or performance. On the other hand, microwaves, VCRs, and cellular phones were labeled as discontinuous innovations. With a discontinuous innovation or technology, it is not possible to ascertain the core benefit of their benefits because of the radical differences between earlier and later versions with respect to several important characteristics. In addition, later versions of these technologies could be altogether different from the earlier versions resulting in a completely new technology or innovation (Ganesh et al., 1997). Finally, newly introduced innovations often must compete with a technical standard (betamax vs. VHS) (Ganesh et al., 1997). The public is less inclined to adopt a given innovation that does not represent the "predominant standard" in the industry (Ganesh et al., 1997). Perceived risks of the less accepted technology and the burden of learning about the newer technology often preclude its rapid adoption.

The authors found that of the six factors, five—cultural similarity, economic similarity, time lag, type of innovation, and existence of a technical standard—were strongly related to the learning process. Geographical proximity or similarity was not significant in explaining the variance in the learning process. However, the authors revealed that the more similar the lead and lag markets were in the cultural and economic areas, the greater the learning effect was found to be. Time lag was positively related to the learning effect; the greater the time lag, the greater the learning effect between the lead and lag country. The type of innovation revealed that continuous innovations produced a greater learning effect than did discontinuous innovations. Finally, the existence of a technical standard strengthened the learning effect, and vice versa (Ganesh et al., 1997). As Garnesh et al, (1997) state, "once a technological innovation is adopted, consumers may face high switching costs should another competing technology become more attractive' (p. 218).

The Intricacy of Technological Adoption

As evidenced by the literature, the acceptance of technology by the public represents a complex yet predictable process. Public acceptance of a given technology is easier to predict if one understands how the public perceives the inherent attributes of the technology. These perceived attributes are very influential factors in the public's decision-making process. That is, specific attributes of a technology facilitate or hinder public involvement in this innovation or new technology. In fact, technology may be understood as an ambivalent dimension of the social process in which a determination is made through social struggles of what the technology will represent in the present, and what it will ultimately become in the future (Feenberg, 1990) to the public.

In acknowledging that a technology may be employed for destructive purposes, it is important to realize that this acknowledgment will be contingent upon the reasons behind what the technology was supposed to accomplish or the way in which technical principles are employed in comprising the technology in the first place. It will also be based on how the technology is employed regardless of its original purpose (Feenberg, 1990). As a result of this assessment, it is crucial that the public be involved in the formulation of a technology's purpose and utilization. Finally, with the various struggles and controversies inherent in disposal technologies, it is imperative that new social criteria of innovation be developed which respond to the interests of the underlying population. The emphasis should be placed on the role that public participation or involvement plays in technical decision making, and how these decisions may influence social change (Feenberg, 1990). Thus, these considerations are crucial for understanding the process by which an involved public imbues certain characterizations to various environmental technologies or technological innovations.

Public Acceptance of Environmental Technologies

The public is often reluctant to adopt and often opposes various environmentally related technologies. For example, community members frequently ban together to oppose the placement of technologies such as municipal incinerators, landfills, sewage treatment facilities, or nuclear power plants. The public's aversion toward the placement of such technologies is often referred to as the (NIMBY), or the "not in my backyard" syndrome (Kemp, 1990). The public's propensity to oppose environmental technology may stem from the attributes of the technology itself. It is plausible to suggest that environmental technologies do not appear on the surface to possess characteristics that facilitate the adoption process. In fact, negative connotations and threatening imagery often plague such innovations. For example, people often associate nuclear materials with mushroom clouds and destruction. Additionally, the public is sometimes more accepting of one environmental technology over the other. The public is frequently inclined to make relative, sometimes erroneous comparisons between two or more technologies. Such comparisons result in the public advocating the use of a given technology and opposing the use of the other. For example, some communities surrounding U.S. DOE Nuclear Weapons sites have advocated that nuclear materials be used for fuel rather than immobilized and stored.

Public advocacy or opposition toward environmental technology goes beyond its perceptions toward technological attributes. When choosing a stance on technology, the public also closely scrutinizes the people or institutions responsible for designing, implementing and evaluating the technology (Williams, Brown, and Greenberg, 1999). Additionally, the manner in which these people or institutions convey various aspects of the technology to the populace also plays a key role in the public's willingness to adopt the innovation. The diffusion process is greatly influenced by the perceived credibility of those responsible for informing the public about the technology. If an information source such as the Army lacks credibility, the public may be less inclined to accept a given technology. Institutional credibility has been found to enhance the risk communication process, even more so than knowledge (Frewer and Sheperd, 1995; Bradbury, 1994; Binney, Mason, Martsolf, and Detweiler, 1996).

Public trust appears to play an important role in public acceptance of technical decisions related to environmental management. It is likely that the American populace places much trust in the Army's ability to develop lethal technologies. However, the public may be wary of the Army's ability to develop and implement protective technologies. Federal groups in general have had difficulty in convincing the public to trust federal decisions concerning the environment. The U.S. Department of Energy's (DOE) legacy of public mistrust is well-documented (Binney, Mason, Martsolf, and Detweiler, 1996; Peters, Covello, and McCallum, 1997; Kunreuther, Easterling, Desvousges, and Slovic, 1990). For example, DOE's lack of public credibility has seriously hindered its ability to transport waste materials (Binney, Mason, Martsolf, and Detweiler, 1996). Studies suggest that a symbiotic relationship or a full partnership between agencies and local citizens are requisite conditions for effective technological decisions (Binney, Mason, Martsolf, and Detweiler, 1996). Other studies have suggested that public involvement in technical decisions may ameliorate the decision-making process (Williams, Brown, and Greenberg, 1999). The implications of technological risks or the fear the public may have of certain technology is relevant to understanding the public's desire to control this technology.

According to Freudenburg and Pastor (1992), trustworthiness, power, and social control are manifestations of technological risks, and result in the differentiation between technological versus financial or recreational risks. For example, when persons trust their friends or their investments with a financial institution, they have a certain level of control, including the option to invest their monies elsewhere or not at all. On the other hand, when local residents are told that an incinerator will be built near their home, they may have no choice or control over the matter. They will have to accept or protest decisions that other individuals have made for them. Trust was also found to have importance when the public had to deal with competing sources of technical information (Freudenburg and Pastor, 1992). Soden (1995) found that the level of trust the public had with each competing source of technical information on environmental issues, was an important consideration for policymakers and individuals involved in information dissemination programs. Furthermore, it was determined that the various levels of trust the public had with environmental issues were an attribute of these issues. That is, trust was attached to the issues themselves because various entities or sources played specific roles in their promotion of a strong position on these issues thereby facilitating this link between trust and an environmental issue (Soden, 1995).

The public's perceptions toward environmentally related technologies are not well documented. The Army is under an international mandate to safely dispose of its chemical stockpile by the year 2007 (U.S. Library of Congress, 1993; Blackwood, 1999). Consequently, the Army needs to better understand the public's concerns regarding such disposal if it is to achieve its mandated mission. This study represents an effort to gain such an understanding.

The Chemical Weapons Stockpile Community Study

This study was conducted through an independent contract between the University of Arizona and the U.S. Army's Program Manager for Chemical Demilitarization (PMCD). Although funded by the U.S. Army, researchers at the University of Arizona conducted this investigation independent of Army oversight. As mandated by international treaty, the primary charge of PMCD is to safely dispose of the U.S Army's stockpile of chemical warfare materiel. Additionally, PMCD is required to engage the public and to integrate public input into the programmatic decision-making process. PMCD has been the target of much criticism concerning public involvement (Shepherd and Bowler, 1997). Critics of the program argue that public participation opportunities for the programmatic EIS were a "pro forma exercise" (Shepherd and Bowler, 1997; p.6). They also contend that Army decisions have been "unilateral, unfair, and unsafe"(Shepherd and Bowler, 1997; p.6). However, there is little empirical substantiation of such assertions. This study represents an effort to better understand the public's views concerning various aspects of chemical demilitarization so as to provide the foundation for more effective public outreach and education.

Methodology

Researchers conducted a cross-sectional descriptive and analytical study of variables related to environmental risk perception, policy, and management in ten states. Preparation and planning of this investigation began in March of 1998 and ended in February of 1999. During the preparation phase of this study, secondary data sources were obtained and analyzed for the purpose of sample selection and stratification. Field-testing of research protocols and instrumentation was conducted between February and March 1999. Collection of primary data began in April 1999 and ended in July 1999.

Study Region Characteristics

The U.S. Army's chemical stockpile sites are located in eight states: Alabama, Arkansas, Colorado, Indiana, Kentucky, Maryland, Oregon, and Utah. There is an additional chemical stockpile site located at Johnston Atoll in the Pacific Ocean, approximately 800 miles southwest of Hawaii. This site was not included in this investigation. Only the Deseret Chemical Depot near Tooele, Utah and the Johnston Atoll Chemical Agent Disposal System are actively disposing of their chemical weapons stockpile. The estimated population for the study area at each site is as follows: Anniston (n=326,175; Blue Grass (n=126,179); Edgewood (n=231,627); Newport (n=156,680); Pine Bluff (n=155,539); Pueblo (n=132,901); Tooele (n=31,410) and Umatilla (n=74,385). The estimated total population of the eight-site study region in 1997 was 1,234,896.

Instrument Development: The Chemical Demilitarization Stakeholder Instrument (CDSI)

The Chemical Demilitarization Stakeholder Instrument (CDSI) was systematically developed and reviewed by a broad cross section of residents, community activists, and government agency representatives living in the communities surrounding the chemical stockpile sites. At each location, a site specific "survey team" was convened. Overall, approximately 150 individuals agreed to serve on the survey teams. The primary purpose of convening these teams was to increase the likelihood that the scope, methods, and instrumentation were contextually appropriate for each given community being studied. Once established, each team was briefed concerning the purpose of the study and the nature of their participation. The teams were periodically reconvened as required by the developmental process.

Identification of Survey Objectives: Site specific survey teams systematically identified and prioritized objectives for the population survey. Using a quasi Delphi protocol, each team member was polled a total of four times over the course of about a three month period. The first two rounds of this protocol were designed to identify a manageable number of issues that the teams indicated were important. A list of 53 broad survey objectives was given to the teams, who were then asked to clarify and rate the importance of each objective. For example, a preponderance of survey team members identified "residents' perceptions of risk" as an important topic for the CDSI to cover. Once the objectives were clarified and rated during round one, the list was condensed into 28 objectives and redistributed to the teams for use in round two. The next three rounds required members to rank order the content areas in order of importance so that more important areas would receive the most coverage on the CDSI. Group agreement was assessed using mean rank scores and coefficient of variation. Upon completion of round two, group consensus was high with respect to 16 of the 28 objectives.

During round three, the remaining 16 objectives were redistributed to the teams. The revised list was ranked in accordance with the overall groups' rankings. Members were asked to rank each content area again. During round four, this process was repeated. However, this time members were asked to rank each area within two places of the group's aggregate rankings, thus considering the group's collective opinion on the areas. Members were instructed that if they did not agree with the groups ranking within the two-place limit, then he or she should provide a brief rationale behind their divergent position. Upon completion of round four, content areas were prioritized using mean rankings and coefficient of variation. Additionally, researchers carefully examined dissenting opinions to help them understand areas in which consensus was not obvious. A final list of 16 objectives was constructed and prioritized based upon the all the information obtained throughout the process (See Appendix A). The list of objectives was used as a “blueprint” for the CDSI. Using a table of specifications, an item pool was developed based upon the content area list generated from the team survey. A greater number of items were generated for “high priority” areas than for “low priority” areas.

Focus Groups: The site-specific survey teams were not the only people who provided input into the survey development process. At each of the eight sites, researchers conducted two focus groups, for a total of 16 focus groups. A total of 106 people participated in the focus groups. The purpose of the focus groups was to provide local citizens with the opportunity to identify objectives for the survey using a less formal assessment approach. Focus groups were conducted using a conventional nominal group process. Participants were asked three questions in which they eventually had to rank order their position on a given topic. Data were collected using field notes and standard rating scales. Each focus group was also videotaped, if the participants signed a written informed consent and video consent form. Taping the sessions allowed researchers to carefully review sessions later and capture information that was missed during the actual session. Data obtained from the sessions were used to structure the overall objectives for the survey and to generate survey items.

The CDSI is a closed and open-ended item questionnaire that was designed specifically for telephone interviewing (See Appendix B). A total of 124 items were developed and systematically field-tested for use in the CDSI. The large number of items was required to cover the entire breadth of areas identified by the survey teams. Consequently, three versions of the CDSI were composed to decrease respondent burden and to increase response rates. All three versions consist of 45 core items. Versions A, B, and C contain 85, 78, and 81 items respectively.

Item functioning was assessed using classic item analysis. The entire item pool was field-tested before final inclusion in the CDSI. Seven hundred and seventy-one interviews (n=771) were completed during the field-test. Field-test data were used to evaluate items with respect to discrimination, difficulty, and reliability of intact scales. A point-biserial correlation was used to evaluate an item’s ability to differentiate among respondents answering in opposing directions. Only items with discrimination values above .30 were retained in the final version of the CDSI. Optimal difficulty levels (p-value) are a function of the item format. Dichotomous and 5-point Likert scale items were the primary item formats used in the CDSI. The optimal p-value for a dichotomous item is .75 and .60 for a five-option item. Only items with p-values within $\pm$ .10 optimal values were retained in the final version of the CDSI. Cronbach’s Alpha was used to estimate the internal consistency of intact scales. During field-testing, a Cronbach’s Alpha (α) of .80 was established as the minimal acceptable reliability for any given scale. Items that decreased the scale reliability below the .80 level were typically omitted. Data obtained from the actual study indicated that the mean Cronbach Alpha (α) for nine CDSI scales was .82.

The CDSI was comprised of ten intact scales. Likert-type scales included the Emergency Preparedness Scale (EPS), the Risk Perception Scale (RPS), the Outreach Awareness Scale (ORS), the Army Trust Scale (ATS), the Disposal Technology Characteristic Attribution Scale (DTCAS), the Army Descriptor Scale (ADS) and the Participation Intent Scale (PIS). Polychotomous scales included Emergency Preparedness Action Scale (EPAS), the Programmatic Awareness Scale (PAS), and the Civic Participation Scale (CPS). The Programmatic Awareness Scale (PAS) was not used in this analysis because of poor reliability. The estimated reliability for this scale was .44, well below common reliability standards.

Quality Assurance/Control Procedures

Researchers engaged in the following quality assurance and control procedures throughout the study: (1) field-testing and psychometric evaluation of instrumentation; (2) recruitment and standardized training of interviewer personnel; (3) objective testing of interviewer knowledge; (4) assessment of interviewer field performance and (5) standardization of interview administration protocols. The purpose of these procedures was to decrease the potential for interviewer/respondent bias, sampling bias, and other sources of systematic errors associated with the interview process.

Sampling

Using random digit dialing (RDD), a total of 24,058 residents across the eight sites were called and asked to participate in the survey. RDD has been found to increase the generalizability of telephone surveys (Kristal et al., 1993). The total population for this eight-site region in 1997 was estimated at 1,234,896 (U.S. Bureau of the Census, 1999). The sample was stratified with respect to ethnicity and place of residence. Ethnic stratification was based upon the proportion of ethnic minority groups living within each of the eight respective regions.

Residential stratification was based upon the proportion of residents living within emergency response zones. These zones are used to plan and implement emergency evacuation and response protocols in case of an accidental release of chemical agent that travels beyond the perimeter of the site. Ten states and forty counties fall within the emergency response zones (Salter, 1999). At seven of the eight sites, emergency response zones are subdivided into Immediate Response Zones (IRZ) and Protective Action Zones (PAZ). At the Edgewood, Maryland site no such distinction is made. The IRZ and PAZ represent indicators of residential proximity to the outer perimeter of a given site. The IRZ represents a geographic area that directly borders the entire site, thus closest to where the chemical agent is stored. IRZs fall within an estimated six to nine mile radius of the site (Salter, 1999). PAZs fall within an estimated six to thirty-one mile radius of the site (Salter, 1999). The PAZ represents a geographic area that surrounds the entire IRZ. The ERZ in Edgewood, Maryland area does not differentiate with respect to residential proximity, it only designates a general area around the perimeter of the site as an emergency preparedness zone.

Respondents were delimited with respect to age, birthday, and residential zipcode. Only those individuals who were 18 years old or above and whose zipcode fell within the emergency preparedness zones were permitted to complete an interview. Once a contact was made within the home, the "next birthday" method was used to randomly select respondents "within" the home itself. Prior to beginning the interview, callers asked the person answering the telephone if there was anyone else in the home who is 18 years of age or older. If so, callers asked to speak to the person in the home whose birthday was next. If not, the person answering the telephone was permitted to complete the interview. This approach is advocated in the literature as a way to decrease sampling bias (Oldendick and Link, 1994; Oldendick, Bishop, Sorenson, and Tuchfarberber, 1988; O'Rourke and Blair 1983).

Sample Size: Sample size was determined through power analysis. The range of variables to be investigated, the desired level of precision, confidence levels, the degree of sample variability and the estimated proportion of households in each county in the region with access to a phone were all factored into the analysis. Since a survey of precisely this nature had not been done previously, the variability of the variables being studied within the target population is unknown; thus, maximum variability (p =0.5) was assumed. A simplified power analysis formula for proportions was used for calculating sample size. In terms of sampling, residents living within the IRZ, PAZ, and ERZ were sampled within ± 3-4%, a ± 4-5%, and a ± 5% margin of sampling error respectively. The power analysis indicated that approximately 8,000 respondents were needed to meet the above margins of sampling error.

Data Collection

Data were obtained using a Computer Aided Telephone Interviewing (CATI) system. Telephone-based surveys generally evoke higher response rates than do mail computer, and household surveys, particularly in large population studies. Telephone numbers were obtained from a commercial sampling firm and downloaded to the CATI system. Calls were made between the hours of 8:00 a.m. and 9:00 p.m. (Mountain Time), Monday through Friday, and 10:00 a.m. to 3:00 p.m. on Saturday and Sunday. If initial contact was not made with a given number, then the number was "called-back" at least 10 times before it was eliminated from the sample. In order to maximize the use of sample pools, some numbers were called as many as 20 times before elimination.

Once contact was made, the interviewer undertook the following procedures. First, the interviewer stated the purpose of the call and had the respondent confirm his or her telephone number, zipcode, and state of residence. Secondly, as described previously, the interviewer solicited the participation of the adult person in the household having the next birthday. Once the respondent met the delimiting criteria, he or she was read an informed consent and subsequently asked if he or she would volunteer to participate. The informed consent described how any respondent could terminate his or her participation at any point in the interview, or decline to answer any question without risk of reprisal or could reschedule the interview at a more convenient time. Investigators were required by our Institutional Review Board to obtain verbal Informed Consent from each participant. If consent was given for the interview, the subject was then automatically assigned a respondent ID code by the CATI system to identify his or her responses. The ID code was separated from any potential identifiers of the respondent (e.g., name, address, telephone number, etc.). Each respondent's answer to specific items (e.g., open-ended items) was recorded directly into the computer to limit the potential for data transfer error.

Research Variables

Individual Level Variables: Participation in Civic Activities and Participation Intent represent the two *criterion* variables included in this analysis. The Civic Participation Scale and the Participation Intent Scale measured the two criterion variables respectively. Individual and site level factors were used as predictor variables for this analysis. Individual-level *predictor* variables were obtained from the CDSI. These variables included emergency preparedness, perceptions of risk, awareness of outreach, trust in the Army, attribution of disposal technology characteristics, and respondent socioeconomic characteristics. The predictor variables were measured by the Emergency Preparedness Scale, the Risk Perception Scale, the Outreach Awareness Scale, the Army Trust Scale, the Disposal Technology Characteristic Attribution Scale, and respondent characteristic items respectively.

Community Level Variables: A total of 26 community level variables were included in the analyses. The value of each variable is illustrated in Table 1.0 below. Categories of variables included population indices, birth and death rates, violent crime rates, literacy rates, economic indices (e.g., poverty), voter characteristics, political control, site characteristics, outreach characteristics, and number of known activist groups. Mean values were calculated for each variable whenever appropriate. Once calculated, each mean value was weighted in direct proportion with the estimated population within the geographic area sampled. Each respondent was assigned a site-specific value for each of the 26 community variables. For example, all respondents living in the Anniston area would have been assigned a value of "5.13" for violent crime rate.

Table 1.0 Community Level Variables by Site

	SITE							
	Anniston	Blue Grass	Edgewood	Newport	Pine Bluff	Pueblo	Tooele	Umatilla
Pupil/Teacher ratio by Site	18.24	16.42	16.99	22.66	16.92	16.20	21.37	16.94
Population Density	156.63	120.40	1015.30	71.80	72.83	54.84	1082.93	18.13
% Population Change	1.24	6.35	2.85	-1.24	3.39	5.77	5.84	5.29
% Population >65 Change	1.28	5.59	8.02	-3.25	-.72	3.39	3.89	.92
% Change in Birth rate	3.07	5.59	-.20	-6.10	5.48	2.46	11.32	3.89
Age Adjusted Death Rate	626.71	485.13	471.03	547.20	595.32	481.00	434.76	493.13
Crude OBS Death Rate	1144.36	831.62	892.53	1191.20	1009.14	991.60	576.71	918.86
Violent Crime Rate	5.13	1.50	6.19	.58	7.28	9.31	3.51	1.65
% 1990 Population at Level 1 Literacy	24.43	17.41	15.24	17.19	25.17	21.00	11.11	18.00
% Students Free Lunch Eligible	37.30	33.00	19.02	6.73	33.10	35.90	18.17	31.75
Total Site Population 1996	322985	124577	944889	156564	154293	130997	857830	73788
Number of Counties in Analysis by Site	5	4	3	5	4	1	2	2
% Population in Poverty	18.15	18.46	6.45	12.54	20.21	18.30	8.82	15.91
% Population K-12	17.12	16.29	15.31	20.18	22.53	18.03	22.11	19.89
Businesses Established / Population	.015	.017	.022	.020	.018	.025	.027	.025
Median Income	26952	28131	42021	29919	29676	27589	39467	30021
Number of Activist Groups	4	2	3	1	3	1	4	3
Outreach Office Full Time Employees	3	2	2	2	4	1	4	3
Number of Four-Year Colleges in Area	1	2	4	0	1	1	2	1
Total Registered Voters	164639	77479	466997	96459	75590	82601	477319	43058
General Election Turnout Avg.	56.60	49.40	64.74	45.65	50.86	55.00	48.00	55.88
Activist Groups/Population	.000013	.000016	.000003	.000006	.000019	.000008	.000005	.000041
Site's Mission Post-Demil [a]	2	2	2	1	2	1	1	1
Governor's Political Affiliation [b]	2	2	2	2	1	1	1	2
Senate Party Control [c]	1	1	2	3	3	1	1	3
State House Party Control [d]	2	2	2	2	2	1	1	1

Note: All mean values are weighted by population sampled.

a. 1=No Further Mission, 2=Continued Missions

b. 1=Republican, 2=Democrat

c. 1=Republican, 2=Democrat, 3=Split

d. 1=Republican, 2=Democrat

Treatment of Data

The intent of the analysis was to establish a model that can assist in the prediction of public perceptions and behavior. The most commonly used statistical method to identify predictive models of this type is the Ordinary Least Square (OLS) multiple regression method. However, the potential predictor variables used in this study can be divided into two different types: *Personal* variables such as occupation, participation in public affairs, family size, and educational level; and *community* variables such as population density and the number of activist groups in the community. These two types of variables contain different statistical characteristics. Specifically, all individuals within the same site share the same set of community characteristics while these same individuals may differ among themselves in personal characteristics. Statistically, this is referred to as a nested design in that individuals reside (are nested) within sites. For the purpose of statistical analyses and for meaningful interpretation of results from these analyses, this nested design presents a number of known technical problems (e.g., aggregation bias, unit of analysis problem, misestimated precision problem).

In order to resolve these problems and to produce the most reliable and stable prediction models, the Hierarchical Linear Modeling (HLM) method, which is specifically designed for this type of multilevel, nested data structure, is used (Arnold, 1992). When applied to this study, the HLM analysis approach essentially divides the prediction problem into two sets of prediction questions at two different levels:

1. What personal variables can predict a person's perceptions toward a disposal technology?

2. How will the prediction models for Question 1 change as a function of the values of the community variables for the site in which the person resides?

To illustrate symbolically, using Y to represent the dependent variable of interest and X_1, X_2, ... X_k (e.g., religion, education, occupation) to represent different personal variables, we can attempt to answer the Question 1 by identifying the best linear regression equation of the form:

$$Y = b_0 + b_1 X_1 + b_2 X_2 \ldots + b_k X_k + e \qquad (1)$$

where the β's are regression weights and e is the error of prediction. This equation is referred to as the *Level-1 Model.*

To answer Question 2 above, we use symbolically Z_1, Z_2, ... Z_m (e.g., proximity to disposal site, number of activist groups) to represent community variables. We attempt to predict how the β values in Equation (1) will change as a function of these Z values by estimating:

$$\begin{aligned}
b_0 &= g_{00} + g_{01} Z_1 + g_{02} Z_2 + \ldots + g_{0m} Z_m + u_0 \\
b_1 &= g_{10} + g_{11} Z_1 + g_{12} Z_2 + \ldots + g_{1m} Z_m + u_1 \\
b_2 &= g_{20} + g_{21} Z_1 + g_{22} Z_2 + \ldots + g_{2m} Z_m + u_2 \\
&\ldots \\
&\ldots \\
b_k &= g_{k0} + g_{k1} Z_1 + g_{k2} Z_2 + \ldots + g_{km} Z_m + u_k \qquad (2)
\end{aligned}$$

where the γ's are regression weights and the *u*'s are errors of prediction. These are referred to as *Level-2 Models.* As the intercept and regression weights in the Level-1 model are determined by the Z values in the Level-2 models, community variables would influence how personal variables can predict a person's risk-related perceptions.

Analysis Procedure

Exploratory Analysis Steps: Through a large-scale survey, researchers established a comprehensive data set containing information gathered from over 8,000 individuals from eight different chemical weapons stockpile communities. This database contains information for numerous personal variables and community variables. The main goal of the analysis is to identify the best predictors of a person's score on a number of outcome variables. However, there is no strong *a priori* theory that may suggest specific predictor variables. Therefore, to conduct the HLM analysis in practice, we used an exploratory approach. Specifically, we performed each of the following steps for each of the desired dependent variables:

Step One: The database containing all the variables of interest were examined carefully for missing data and other irregularities such as extreme skewedness. Appropriate transformations, mean substitutions, and the creation of subsets of data were performed to assure the most robust data set for analyses.

Step Two: As mentioned previously, scale scores were generated for various subscales by summing appropriate items within these scales. Specifically, the following scale scores were created:

- Participation Intent Score (DESCSUM) is the sum of the scores for the seven polychotomous items (DESC_1 to DESC_7). This variable indicates "*intent to participate.*" The higher the Participation Intent score (DESCSUM), the more a respondent is personally ready to participate in site-related decisions.

- Risk Perception Score (ACTYSUM) is the sum of the scores for the 13 Likert scaled items (ACTY_1 through ACTY_14). This variable indicates a person's perception of risk associated with site or site activities. The higher the Risk Perception score (ACTYSUM), the more a respondent perceives a susceptibility to an adverse outcome associated with the site.

- Civic Participation Score (PARTSUM) is the sum of the scores for nine polychotomous scaled items (PART_1 through PART_9). This variable indicates the level of "civic participation". The higher the Civic Participation score (PARTSUM), the more a respondent participates in civic activities.

• <u>Outreach Awareness Score</u> (PGSUM) is the sum of the scores for nine Likert scaled items (PGM_1 through PGM__8). This variable indicates the respondent's perceived awareness and value of public outreach. The higher the Outreach Awareness score (PGSUM), the more the respondent is aware and values public outreach activities currently taking place at the site.

• <u>Incineration Score</u> (INCINSUM) is the sum of all the responses to eleven polychotomous items (INEUT_1 through INEUT_11). This variable indicates the degree to which a respondent attributes positive characteristics with the incineration method of disposal. The higher the Incineration score (INCINSUM), the more the respondent has ascribed positive traits to incineration.

• <u>Neutralization Score</u> (NEUTRSUM) is the sum of all the responses to eleven polychotomous items (INEUT_1 through INEUT_11). This variable indicates the degree to which a respondent attributes positive characteristics with the neutralization method of disposal. The higher the Neutralization score (NEUTRSUM) the more the respondent has ascribed positive traits to neutralization.

Step Three: The data prepared in the steps one-two were submitted to an ordinary least square regression analysis through the SPSS (Statistical Packages for Social Sciences) software using only personal variables. The purpose of this analysis is to identify statistically significant level-1 predictor variables to improve the efficiency of subsequent analyses.

Step Four: The data were then submitted to an HLM analysis through the software HLM (v.4.01) using only significant level-1 predictor variables identified from Step 2 above. For the level-2 variables, all variables of potential interest were examined one-by-one in an exploratory process to identify significant level-2 predictors.

Step Five: After the final set of significant level-1 and level-2 variables have been identified through steps 3 and 4, a final HLM analysis using only these variables was performed to estimate the final set of parameters.

Step Six: The above process is repeated for each dependent variable of interest and each appropriate subset of data created.

Generating Subsets of Data*:* Because of the use of different versions of certain scales within the overall CDSI, several independent and dependent variables suffered severe problems of missing data primarily due to non-overlapping items. If these variables were included in the overall analysis, following the common listwise deletion method for the treatment of the missing data would have resulted in no usable data at all. To remedy this problem, it was necessary to create subsets of data so that all variables can be investigated. Therefore, the following data sets were generated from the overall survey database:

Global Data Set: This set of data contains responses to all items from all subjects in the overall survey, except for data related to the following variables: Risk Perception Score (ACTYSUM), Civic Participation Score (PARTSUM), Incineration Score (INCINSUM) and Neutralization Score (NEUTRSUM). These four variables were excluded entirely from this data set. There are a total of 8,223 respondents in this data set. *The Global Data Set was not used for the analyses presented in this paper since the dependent variables Incineration Score (INCINSUM) and Neutralization Score (NEUTRSUM) are not part of this data subset.*

Participation Data Subset: Again, both the Civic Participation scale and the Disposal Technology Characteristic Attribution scale in the overall data set had several non-overlapping versions. In order to include Civic Participation Score (PARTSUM), Incineration Score (INCINSUM) and Neutralization Score (NEUTRSUM) in an analysis simultaneously, we selected only subject who responded to Version A of Civic Participation Scale. There are a total of 2,539 respondents in this subset of data.

Risk Perception Data Subset: Both the Risk Perception scale and the Disposal Technology Characteristic Attribution scale in the overall data set had several non-overlapping versions. In order to include Risk Perception Score (ACTYSUM), Incineration Score (INCINSUM), and Neutralization Score (NEUTRSUM) in an analysis simultaneously, we selected only subjects who responded to Version B of the Risk Perception scale. Any other combination would have resulted in having no subjects at all. There are a total of 2,572 respondents in this subset of data.

When the level-2 variables (See Table 1.0) were examined along with the level-1 variables in this data subset for suitability of the particular analyses in this study, a number of problems were found. First, there were over 1,000 cases of missing data for the occupation of the individuals. The problem was considered too severe for any meaningful statistical correction (e.g., imputation). Therefore, occupation was excluded from all analyses involving the ACTY data subset. A more serious problem is the second problem of multicollinearity. We found many level-2 variables to be highly correlated with one another. As illustrated below, some of these were practically linear transformations of other variables. Because of the multicollinearity problem, the redundant variables were reduced as follows:

Intercorrleations among a cluster of multicollinear level-2 variables in ACTY

	W_AVG2	POP96	M_POP96	A_POPOV	MED_INC
POP96	0.985				
M_POP96	0.958	0.926			
A_POPOV	-0.862	-0.856	-0.793		
MED_INC	0.950	0.931	0.881	-0.915	
VOTERS	0.992	0.996	0.949	-0.860	0.927

Given the multicollinearity of the five variables listed above, A_POPOV (percent of population in poverty) was the only level-2 variable used from this group. As illustrated below, another area of multicollinearity among the level-2 variables was also identified and corrected

Intercorrleations among a second cluster of multicollinear level-2 variables in ACTY

	STHOUSE	N_COUNTY
N_COUNTY	-0.881	
A_TEST	0.870	-0.865

Given the multicollinearity of the three variables listed above, STHOUSE (state house party control) was the only level-2 variable used from this group Finally, a high intercorrelation (-0.893) was also identified between Senate and the variable W_AVG4. Hence, SENATE (senate party control) was used instead of the W_AVG4 variable.

Following the exploratory steps described earlier, each of these *two* data sets were analyzed to identify predictors of Incineration Score (INCINSUM) and Neutralization Score (NEUTRSUM).

Results

Response Characteristics

Interviewers made 24,058 telephone contacts from April to July 1999. Approximately 10,183 residents agreed to participate in the study, 8,315 of these residents completed the entire survey. A total of 2.9% of respondents had participated in a survey within the past year. The literature suggests that refusal rates increasingly pose a source of bias for telephone surveys (Hox and Leeuw, 1994; Schmidley, 1986; Smith, 1995). The rate of respondent refusal to participate in this study is comparable to that of other large population surveys (Smith, 1995; Luevano, 1994; Davis and Smith, 1992).

The *immediate refusal rate* was 53% across all sites and ranged from 36% in Umatilla, Oregon to 61% in Edgewood, Maryland. Immediate refusals occur very early in the contact with a potential respondent before the respondent is given a description of the survey. The vast majority of immediate refusals come within the first minute of the contact, well before the interviewer has an opportunity to encourage the person to respond. This refusal rate is sometimes referred to as a “cold refusal” or a “phone slam.” Given the public’s increasing annoyance with “telemarketers,” some researchers have questioned the efficacy of using immediate refusals as an indicator of willingness to respond (Baker, 1996; Whitlark and Geurts, 1998; Reagan, Pinkleton, Aaronson, and Ramo, 1995).

Some survey research groups attempt to decrease immediate refusals by calling a respondent after he or she has declined to participate. A respondent may be called as many as 2-3 times, before a respondent gives a “final” refusal. Although refusals can be reduced through such follow-up, calling back unwilling respondents poses both ethical and methodological concerns. First, “voluntary participation” represents a fundamental principle of ethical human subjects research. Secondly, there is some question concerning the extent to which a given respondent’s answers are biased by interviewer “pressure” to participate. For example, interviewers may not develop a good rapport with pressured respondents, thus limiting or altering disclosure. There is insufficient evidence in the literature documenting the effects of following up on refusals. Consequently, more research is needed before such practices become more commonplace.

In this study, interviewers were not allowed to call an unwilling respondent back. In accordance with the University of Arizona Institutional Review Board directives, researchers must adhere to a respondent’s wishes to end his or her participation at any time during the study. Once informed of the purpose of this study, the vast majority of residents (79%) agreed to participate. This rate is comparable with that of other large population surveys (Smith, 1995; Luevano, 1994; Davis and Smith, 1992). The *refusal rate after consent* was 21% across all sites and ranged from 12% in Umatilla, Oregon to 28% in Pine Bluff, Arkansas. Of the 10,183 residents who agreed to participate, 8,315 residents completed the entire survey and 1,272 residents partially completed the survey process.

Sample Characteristics

Using 1997 projective U.S. Census data for comparison, the demographic characteristics of the sample were similar to demographic characteristics of the eight-state study region. In terms of *race*, 7% of this sample self-identified as African Americans as compared to approximately 13% of eight-state study region. In the sample, 87% of the respondents identified themselves as Caucasian, while the actual percentage of Caucasians in the study region was estimated at 86% for all Whites, regardless of ethnicity. Native Americans constitute approximately 1% of the population in the study region and comprised slightly more than 1% of the sample. With respect to *ethnicity,* 6% of the study region are Hispanic while 5% of the sample self-identified as Hispanic.

The sample and study region differed slightly with respect to age distribution. The age distribution comparisons are based upon the *population eligible* to participate in the study: i.e. those over the age of 18. However, the age intervals for U.S. Census data start at 15 years of age not 18. Hence, the age distribution data for the study region are likely underestimated to a small degree. This probably accounts for the small disparities between the sample and study region. In the study region, 27% of residents were between the ages of 25 and 39 as compared to 30% in the sample. In the study region, 38% of residents were between the ages of 40 and 64 and 9% were between the ages of 65 and 74. Of those sampled, 46% were between the ages of 40 and 64 and 9% were between the ages of 65 and 74. Both the sample and study region consist of a relatively small percentage of people over the age of 74. In the study region, 7% of residents were over the age of 74 as compared to 4% of those in the sample.

In terms of *income*, the study region and the sample residents have similar profiles. The average median annual income for the study region is $30,000. In the sample, 19% reported an income between $25,000 and $35,000 per year and 24% reported an income between $35,000 and $50,000 per year. These categories represented the greatest proportion of respondents in the sample. In the study region, the mean proportion of persons of all ages in poverty is 15%. The proportion is 16% for those in the sample with a family size of 4 or greater and reported incomes of $25,000 or less.

The sample and study regions were also comparable with respect to gender. In the study region, 49% of the respondents identified as male. In the sample 41% of respondents identified as male. Although males are typically underrepresented in population surveys, the male representation in this sample is comparable to other large population surveys.

Characteristic Attribution of Incineration and Neutralization Technologies

Each respondent was provided with the opportunity to attribute specific positive characteristics to either incineration or neutralization technologies. The *Disposal Technology Characteristic Attribution Scale* (DTCAS) was used to measure the reported participation among respondents. A list of 11 characteristics was read to the respondent. These characteristics represent positive factors that have been found to facilitate the adoption of a given technology (Oldenburg, Hardcastle, and Kok, 1997; Rogers, 1995a). The specific characteristics used in this study are described in Table 3.0.

For each characteristic, the respondent was asked to indicate whether the characteristic described incineration, neutralization, both technologies, or neither technology. A respondent was also given the opportunity to indicate that he or she does not know if a given characteristic is descriptive of incineration or neutralization. A neutralization score and an incineration score was derived from these responses. Each time a respondent credited a characteristic to either incineration or neutralization, one point was added to the respective score. If the respondent credited both technologies with a characteristic then one point was added to both scores. If the respondent did not credit either technology with a characteristic then nothing was added to either score. Hence, scores on the DTCAS ranged from "0" to "11". The higher the score, the more frequently respondents indicated positive characteristics with the technology. For example, higher neutralization scores indicate that respondents attributed more positive characteristics with the neutralization technology than they did with the incineration technology.

Table 2.0 provides a breakdown of incineration and neutralization scores by site and across sites.

Table 2.0

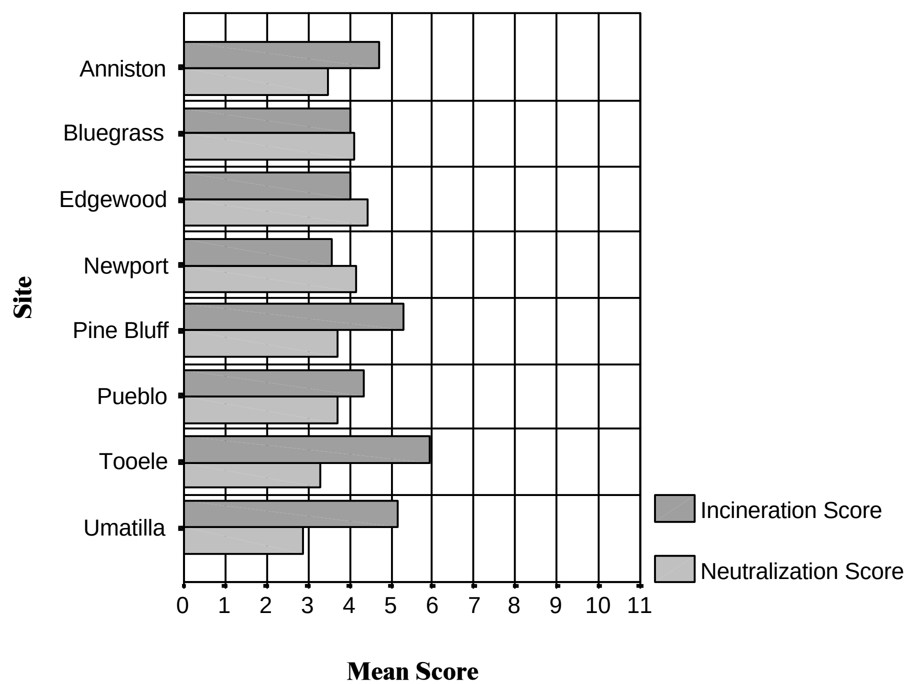
Mean Disposal Technology Score by Site and across Sites

		SITE								
		Anniston	**Bluegrass**	**Edgewood**	**Newport**	**Pine Bluff**	**Pueblo**	**Tooele**	**Umatilla**	**Total**
Incineration Score	**Mean**	*4.72*	*4.03*	*4.02*	*3.57*	*5.27*	*4.33*	*5.91*	*5.14*	*4.65*
	Std Deviation	2.77	2.52	2.47	2.53	2.85	2.69	2.96	2.99	2.83
Neutralization Score	**Mean**	*3.48*	*4.09*	*4.41*	*4.16*	*3.72*	*3.68*	*3.27*	*2.88*	*3.69*
	Std Deviation	2.54	2.71	2.57	2.79	2.55	2.45	2.53	2.32	2.60

Figure 1.0 provides a graphic illustration of incineration and neutralization score differences by site and across sites.

Figure 1.0

Mean Technology Score by Site and Across Sites



As illustrated in Table 2.0, incineration scores were higher than neutralization scores in five of the eight sites. In the remaining three sites, neutralization scores were higher than incineration scores. Using paired t-tests as the test statistic, the differences between mean neutralization and incineration scores were statistically significant for all eight sites ($p. \leq .05$). However, in some cases the differences in mean scores is quite small and lack practical significance (i.e., Blue Grass)

All sites fell within $\pm$ 1.3 points of the overall mean incineration score. Although the range of incineration scores is somewhat narrow, significant differences ($F=54.4$; $p=.000$) were demonstrated in mean incineration scores across the sites. Tooele demonstrated the highest incineration score with a 5.91 mean score while Newport demonstrated the lowest incineration score with a mean score of 3.57. Using a Tukey's post hoc comparison, no significant homogeneous subsets of "low" or "high" mean incineration scores were found.

As illustrated in Table 2.0, all sites fell within $\pm$ .85 points of the overall mean neutralization score. Similar to the incineration scores, significant differences ($F=24.6$; $p=.000$) were demonstrated in mean neutralization scores across the sites. Using a Tukey's post hoc comparison, no significant homogeneous subsets of "low" or "high" mean neutralization scores were found. Table 3.0 summarizes respondents' answers to each of 11 items in the *Disposal Technology Characteristic* Attribution *Scale* (DTCAS).

Table 3.0: Reported Characteristics of Disposal Technology by Site and across Sites

			SITE								
			Anniston	Bluegrass	Edgewood	Newport	Pine Bluff	Pueblo	Tooele	Umatilla	Total
Easy to Understand	Incineration	Col %	24.8%	20.7%	23.9%	16.7%	23.8%	22.7%	32.0%	22.2%	23.5%
	Neutralization	Col %	5.2%	5.2%	5.0%	7.8%	5.8%	4.3%	4.3%	3.3%	5.1%
	Both	Col %	27.6%	31.8%	35.8%	35.8%	30.9%	32.4%	28.6%	24.4%	30.8%
	Neither	Col %	25.9%	26.4%	22.0%	25.5%	22.4%	26.1%	22.0%	27.7%	24.8%
Cost-effective	Incineration	Col %	28.2%	24.8%	31.9%	20.8%	28.0%	26.0%	29.0%	21.1%	26.2%
	Neutralization	Col %	9.8%	13.1%	9.4%	13.0%	7.2%	8.1%	8.0%	8.1%	9.6%
	Both	Col %	11.6%	9.9%	11.4%	10.1%	14.2%	13.1%	12.2%	8.1%	11.3%
	Neither	Col %	21.1%	22.8%	16.3%	21.1%	21.3%	27.4%	19.6%	23.7%	21.7%
The fastest way to dispose of chemical weapons	Incineration	Col %	59.7%	50.6%	53.3%	40.8%	55.1%	51.1%	64.0%	49.2%	53.1%
	Neutralization	Col %	3.8%	8.9%	8.6%	11.6%	6.3%	6.8%	4.1%	4.6%	6.8%
	Both	Col %	5.7%	7.1%	5.0%	3.1%	6.5%	6.6%	4.6%	6.3%	5.6%
	Neither	Col %	5.5%	6.5%	5.0%	6.4%	5.7%	7.3%	3.5%	4.6%	5.5%
A flexible process - meaning it can be tested in parts before being put into full use.	Incineration	Col %	13.2%	6.1%	3.9%	5.4%	15.0%	7.8%	16.0%	14.3%	10.3%
	Neutralization	Col %	20.8%	27.2%	31.5%	25.8%	18.7%	22.1%	16.8%	13.3%	21.9%
	Both	Col %	24.5%	24.1%	26.0%	21.9%	29.1%	25.0%	27.4%	26.1%	25.5%
	Neither	Col %	10.7%	11.7%	6.8%	8.3%	9.6%	12.8%	6.7%	9.1%	9.5%
The least risky way to dispose of chemical weapons.	Incineration	Col %	26.6%	15.4%	13.3%	14.7%	29.6%	20.0%	38.8%	29.7%	23.8%
	Neutralization	Col %	27.4%	34.9%	38.2%	35.0%	22.4%	28.0%	16.0%	14.0%	26.7%
	Both	Col %	5.1%	7.2%	6.0%	4.7%	5.7%	6.4%	8.4%	6.3%	6.3%
	Neither	Col %	15.5%	15.3%	13.8%	12.2%	12.9%	17.8%	8.9%	12.0%	13.5%
A process that is being used by other sites.	Incineration	Col %	35.5%	29.3%	14.5%	19.6%	32.8%	31.4%	33.1%	42.9%	30.1%
	Neutralization	Col %	3.7%	4.0%	3.7%	5.5%	3.5%	6.6%	4.5%	2.7%	4.3%
	Both	Col %	17.5%	20.2%	26.8%	16.8%	22.2%	18.5%	19.0%	11.0%	18.9%
	Neither	Col %	6.0%	7.9%	4.1%	4.7%	5.0%	5.1%	3.0%	2.5%	4.8%
Favored by most people in my community.	Incineration	Col %	19.9%	9.4%	7.3%	9.8%	24.3%	14.8%	39.9%	32.6%	20.2%
	Neutralization	Col %	18.5%	26.2%	28.9%	28.3%	12.3%	14.8%	5.6%	5.2%	17.1%
	Both	Col %	4.4%	5.6%	5.0%	6.1%	9.1%	6.1%	9.3%	7.8%	6.8%
	Neither	Col %	25.6%	26.1%	12.4%	15.0%	22.2%	23.3%	11.3%	13.9%	18.6%
Better than long term storage of chemical weapons.	Incineration	Col %	21.4%	12.1%	11.5%	9.0%	21.4%	15.4%	30.6%	25.5%	18.6%
	Neutralization	Col %	16.8%	20.0%	21.3%	25.1%	13.1%	16.7%	8.3%	6.5%	15.8%
	Both	Col %	30.6%	30.5%	36.3%	30.3%	35.0%	31.0%	40.8%	34.3%	33.7%
	Neither	Col %	14.1%	15.4%	12.8%	13.1%	14.3%	16.7%	7.1%	8.7%	12.7%
The BEST way to dispose of chemical weapons	Incineration	Col %	31.2%	18.0%	14.8%	15.7%	31.8%	22.3%	45.0%	36.5%	27.3%
	Neutralization	Col %	21.4%	32.4%	33.5%	33.6%	18.0%	24.5%	11.9%	12.4%	23.2%
	Both	Col %	9.6%	8.9%	11.5%	8.3%	12.6%	12.3%	10.9%	8.9%	10.4%
	Neither	Col %	10.9%	14.7%	11.7%	12.1%	11.2%	12.8%	6.8%	7.8%	10.9%
Beneficial to our local economy.	Incineration	Col %	16.7%	11.4%	10.2%	10.6%	20.6%	11.1%	26.6%	23.8%	16.6%
	Neutralization	Col %	11.9%	12.8%	15.6%	15.6%	9.1%	9.4%	6.4%	6.1%	10.7%
	Both	Col %	19.4%	15.7%	19.0%	19.0%	27.1%	20.4%	26.0%	27.6%	21.8%
	Neither	Col %	31.9%	36.6%	32.0%	28.7%	22.8%	37.7%	21.1%	17.6%	28.5%
Reversible - meaning not permanent.	Incineration	Col %	8.4%	6.1%	6.0%	5.4%	8.5%	5.6%	11.5%	8.4%	7.5%
	Neutralization	Col %	26.3%	24.5%	32.4%	22.9%	26.8%	23.8%	26.6%	17.5%	25.0%
	Both	Col %	13.2%	14.6%	13.0%	15.9%	16.9%	18.8%	14.7%	17.2%	15.6%
	Neither	Col %	21.7%	23.1%	17.4%	17.1%	21.9%	22.5%	16.9%	17.7%	19.8%

Note: Table does not include "don't know" and "refused" response categories.

Overall, *eight* of the *eleven* characteristics were more frequently attributed to incineration than neutralization. The remaining three characteristics were more frequently attributed to neutralization than incineration. The following describes the characteristics most frequently associated with each respective technology and the ratio of association of one technology versus the other. A greater proportion of respondents ascribed the characteristics of flexibility (2.1:1), reversibility (3.3:1), and potential risk (1.1:1) to *neutralization* than they did to incineration. A greater proportion of respondents attributed eight characteristics as descriptors of *incineratio*n rather than neutralization. These characteristics included the following: cost-effective (2.7:1), economically beneficial (1.6:1), understandable (4.6:1), best disposal method (1.2:1), better than storage (1.2:1), favored by community (1.2:1), process being used at other sites (7.0:1), and the fastest disposal method (7.8:1) represent characteristics.

A Pearson Chi-Square (x^2) was used to compare the observed and expected frequencies in each response category and to test the independence of the site versus the eleven response variables. The Lambda (λ) test statistic was used measure the relative reduction in error using the site variable to predict respondents' answers on each of the eleven items, assuming the directions of prediction are of equivalent significance. The range of Lambda is from 0 to 1.

Sites differed significantly with respect to <u>item one</u> ("*easy to understand*") (x^2 =60.00; p. =.000). However, the magnitude of this difference was not statistically significant (λ=.014; p=.113). Sites differed significantly with respect to <u>item two</u> ("*cost effective*") (x^2 =45.70; p. =.000). The magnitude of this difference was statistically significant (λ=.009; p=.015), thus indicating a .9% improvement in one's ability to predict responses in this category. Sites differed significantly with respect to <u>item three</u> ("*beneficial to local economy*") (x^2 =60.68; p. =.000). However, the magnitude of this difference was not statistically significant (λ=.006; p=.200). Sites differed significantly with respect to <u>item four</u> ("*reversible*") (x^2 =168.81; p. =.000). The magnitude of this difference was statistically significant (λ=.016; p=.013), thus indicating a 1.6% improvement in one's ability to predict responses in this category. Sites differed significantly with respect to <u>item five</u> ("*best disposal method*") (x^2 =381.78; p. =.000). The magnitude of this difference was statistically significant (λ=.106; p=.000), thus indicating a 10.6% improvement in one's ability to predict responses in this category. Sites differed significantly with respect to <u>item six</u> ("*better than storage*") (x^2 =268.31; p. =.000). The magnitude of this difference was statistically significant (λ=.020; p=.000), thus indicating a 2% improvement in one's ability to predict responses in this category.

Sites differed significantly with respect to <u>item seven</u> ("*favored by community*") (x^2 =559.05; p. =.000). The magnitude of this difference was statistically significant (λ=.157; p=.000), thus indicating a 15.7% improvement in one's ability to predict responses in this category. Sites differed significantly with respect to <u>item eight</u> ("*process being used by other sites*") (x^2=166.375; p. =.000). The magnitude of this difference was statistically significant (λ=.041; p=.000), thus indicating a 4.1% improvement in one's ability to predict responses in this category. Sites differed significantly with respect to <u>item nine</u> ("*least risky*") (x^2 =307.66; p. =.000). The magnitude of this difference was statistically significant (λ=.106; p=.000), thus indicating a 10.6% improvement in one's ability to predict responses in this category. Sites differed significantly with respect to <u>item ten</u> ("*flexible*") (x^2 =182.125; p.

=.000). The magnitude of this difference was statistically significant (λ=.034; p=.000), thus indicating a 3.4% improvement in one's ability to predict responses in this category. Sites differed significantly with respect to item eleven ("*fastest disposal me*thod") (x^2 =94.656; p. =.000). The magnitude of this difference was statistically significant (λ=.016; p=.000), thus indicating a 1.6% improvement in one's ability to predict responses in this category.

As evidence by these nonparametric tests, the distributions of responses on each of the eleven items differed significantly across the eight sites. With the exceptions of items one and three, the relative reduction in error using the site variable to predict respondents' answers was significant. The range of percentage improvement in prediction was .6% ("*beneficial to local economy)* to 15.7% ("*favored by community*").

It is important to note that a substantial portion of respondents indicated that they did not know if a given attribute describes one technology, either technology, or both technologies. Overall, the median number of respondents answering "don't know" on the eleven items was 28.9%. The range of "don't know" responses was from 15.1% ("easy to understand") to 41.0% ("a process being used by other sites"). As mentioned previously, answers obtained from the Programmatic Awareness Questions were not used because of poor reliability. The median percentage of respondents answering "neither" technology and "both" technologies was 13.5% (σ =7.78) and 15.6% (σ =9.97) respectively.

Analysis I: Perceptions toward Incineration Disposal Method

The focus of Analysis I is a person's perception of the incineration method of chemical weapons disposal (INCINSUM) as the outcome variable to be predicted by various level-1 and level-2 variables. As indicated earlier, INCINSUM data are available only in the PART data subset and in the ACTY data subset. Therefore, two analyses were performed in this study, one using the PART data subset and the other using the ACTY data subset.

Analysis I.A: PART data subset to predict INCINSUM:

When the PART data subset was analyzed through HLM to predict INCINSUM, five (5) significant level-1 predictors were found. However, there was no significant level-2 variable identified. The significant level-1 predictors were PGMSUM, TRUSTSUM, IMPACT (perceived effect of site on community), DESCSUM (readiness to participate), and INCOME (income level).

The maximum-likelihood level-1 prediction equation for INCINSUM based on the PART data subset was found to be:

Level-1 equation:

$$\text{Predicted INCINSUM} = 4.543+0.054(\text{PGMSUM})+0.060(\text{TRUSTSUM}) -0.132(\text{IMPACT})+0.295(\text{DESCSUM})+0.080(\text{INCOME}) \qquad (*\text{I.1})$$

The standard error of the predicted INCINSUM scores from Equations (*I.1) is 2.403. This equation was derived based on centering all level-1 predictor variables. The standard errors and significance of the coefficients for Equation *I.1 are shown in Table *I.T1. The equivalent OLS statistics (e.g., F-ratio, R^2) for Equation *I.1 can be found in Appendix B.

VARIABLE	COEFFICIENT	STD. ERROR	T-RATIO	P-VALUE
Intercept	4.543	0.190	23.935	0.000
PGMSUM	0.054	0.016	3.339	0.014
TRUSTSUM	0.060	0.007	8.647	0.000
IMPACT	-0.132	0.046	-2.898	0.024
DESCSUM	0.295	0.036	8.132	0.000
INCOME	0.080	0.024	3.317	0.015

Table *I.T1: Standard errors and significance for Equation *II.1

Table *I.T2 shows the final estimation of variance components in this prediction model. The results show that the variance component for the intercept is significantly different from zero. The conditional intraclass correlation for the intercept is 0.045.

EFFECT	VARIANCE COMPONENT	DEGREE OF FREEDOM	CHI-SQUARE	P-VALUE
Intercept	0.269	7	91.415	0.000
PGMSUM	0.002	7	21.593	0.003
TRUSTSUM	0.000	7	6.969	>0.500
IMPACT	0.001	7	6.191	>0.500
DESCSUM	0.001	7	3.289	>0.500
INCOME	0.000	7	3.523	>0.500
Level-1 effect	5.772			

Table *I.T2: Final estimation of variance components for Equations *II.1

Interpretation: Equation *I.1 suggests that individuals with high degrees of outreach awareness, who trust army's activities, who perceive a ***negative*** impact of the site on the community, who are ready to participate, and who have a high level of income are more likely to perceive the incineration method of disposal positively. Again, because the metrics for all predictor variables were centered around their respective grand means, the intercept of 4.543 represents the expected INCINSUM score of the typical respondent. To predict the INCINSUM score of any given subject, it is necessary to use the subject's deviation scores on these variables. To facilitate the application of Equation *I.1, Table *I.T3 provides the grand mean score for each of the predictor variables as well as for INCINSUM within the PART data subset.

VARIABLE	N	MEAN	STANDARD DEVIATION
INCINSUM	2,539	4.604	2.745
PGMSUM	2,539	24.290	7.339
TRUSTSUM	2,539	29.896	9.228
IMPACT	2,338	1.953	0.883
DESCSUM	2,538	4.864	1.460
INCOME	2,275	4.795	1.723

Table I.T3: Mean and standard deviation of predictor variables in Equation *I.1

The variance components presented in Table I.T2 show that the intercept has a variance component that is significantly different from zero. This suggests that there remains some unexplained residual variation of INCINSUM associated with the intercept from site to site beyond what is predicted in Equation *I.1. This indicates that the prediction model can be improved by identifying additional site-level variables that have not yet been explored. Further, the conditional intraclass correlation of 0.045 suggests that the residual variance for the intercept is not large but may make a noticeable difference, indicating the need to explore additional new site-level variables in order to predict INCINSUM.

<u>Analysis I.B: ACTY data subset to predict INCINSUM:</u>

When the ACTY data subset was analyzed through HLM to predict INCINSUM, four (4) significant level-1 predictors and no significant level-2 variables were found. The significant level-1 predictors were PGMSUM, INTRUST, DESCSUM, and SEX. SEX refers to the sex of the respondent and was coded as 1=male and 2=female.

The maximum-likelihood level-1 prediction equation for INCINSUM based on the INCINSUM data subset was found to be:

Predicted INCINSUM = 4.981+0.047(TRUSTSUM)+0.546(INTRUST)+0.459(DESCSUM)
-1.218(SEX) (*I.2)

The standard error of the predicted INCINSUM scores from Equations (*I.2) is 2.217. This equation was derived based on centering all level-1 predictor variables. The standard errors and significance of the coefficients for Equation *I.2 are shown in Table *I.T4. The equivalent OLS statistics (e.g., F-ratio, R^2) for Equation *I.2 can be found in Appendix B.

VARIABLE	COEFFICIENT	STD. ERROR	T-RATIO	P-VALUE
Intercept	4.981	0.259	19.201	0.000
TRUSTSUM	0.047	0.016	2.993	0.021
INTRU8T	0.546	0.207	2.639	0.034
DESCSUM	0.459	0.125	3.661	0.010
SEX	-1.218	0.252	-4.834	0.001

Table *II.T4: Standard errors and significance for Equation *I.2

Table *II.T5 shows the final estimation of variance components in this prediction model. The results show that the variance component for the intercept is significantly different from zero. The conditional intraclass correlation for the intercept is 0.078.

EFFECT	VARIANCE COMPONENT	DEGREE OF FREEDOM	CHI-SQUARE	P-VALUE
Intercept	0.418	7	31.378	0.000
TRUSTSUM	0.000	7	3.787	>0.500
INTRUST	0.146	7	11.301	0.125
DESCSUM	0.062	7	8.969	0.254
SEX	0.035	7	6.943	>0.500
Level-1 effect	4.915			

Table *I.T5: Final estimation of variance components for Equations *II.2

<u>*Interpretation:*</u> Equation *I.2 suggests that individuals who trust army's activities, who perceive that the media have made him/her more trusting of weapons disposal activities, who is ready to participate, and who are male are more likely to perceive the incineration method of disposal positively. Again, because the metrics for all predictor variables were centered around their respective grand means, the intercept of 4.981 represents the expected INCINSUM score of the typical respondent. To predict the INCINSUM score of any given subject, it is necessary to use the subject's deviation scores on these variables. To facilitate the application of Equation *I.2, Table *I.T6 provides the grand mean score for each of the predictor variables as well as for INCINSUM within the ACTY data subset.

VARIABLE	N	MEAN	STANDARD DEVIATION
INCINSUM	2,572	4.722	2.913
TRUSTSUM	2,572	29.797	9.146
INTRUST	1,018	-0.111	0.896
DESCSUM	2,572	4.759	1.477
SEX	2,571	1.572	0.495

Table I.T6: Mean and standard deviation of predictor variables in Equation *I.2

The variance components presented in Table I.T5 show that the intercept has a variance component that is significantly different from zero. This suggests that there remains some unexplained residual variation of INCINSUM associated with the intercept from site to site beyond what is predicted in Equation *I.2. The conditional intraclass correlation of 0.078 further suggests that the residual variance for the intercept is not large but may make a noticeable difference, indicating the need to explore additional new site-level variables in order to predict INCINSUM.

Analysis II: Perception of the Neutralization Disposal Method

The focus of Analysis II is a person's perception of the neutralization method of chemical weapons disposal (NEUTRSUM) as the outcome variable to be predicted by various level-1 and level-2 variables. Since NEUTRSUM data are available only in the PART data subset and in the ACTY data subset, two analyses were performed in this study, one using the PART data subset and the other using the ACTY data subset.

Analysis II.A: PART data subset to predict NEUTRSUM:

When the PART data subset was analyzed through HLM to predict NEUTRSUM, three (3) significant level-1 predictors were found. However, there was no significant level-2 variable identified. The significant level-1 predictors were DESCSUM, AGE (age of respondent), and COLLEGE (whether the respondent has completed a college education). COLLEGE was dummy-coded as 1=has completed college and 0=has not completed college.

The maximum-likelihood level-1 prediction equation for NEUTRSUM based on the PART data subset was found to be:

Level-1 equation:

$$\text{Predicted NEUTRSUM} = 3.720+0.173(\text{DESCSUM})-0.032(\text{AGE})+0.299(\text{COLLEGE}) \qquad (*\text{II}.1)$$

The standard error of the predicted INCINSUM scores from Equations (*II.1) is 2.496. This equation was derived based on centering DESCSUM and AGE, but leaving COLLEGE uncentered. The standard errors and significance of the coefficients for Equation *II.1 are shown in Table *II.T1. The equivalent OLS statistics (e.g., F-ratio, R^2) for Equation *II.1 can be found in Appendix B.

VARIABLE	COEFFICIENT	STD. ERROR	T-RATIO	P-VALUE
Intercept	3.720	0.196	18.998	0.000
DESCSUM	0.173	0.077	2.255	0.058
AGE	-0.032	0.005	-6.924	0.000
COLLEGE	0.030	0.115	2.599	0.036

Table *II.T1: Standard errors and significance for Equation *II.1

Table *II.T2 shows the final estimation of variance components in this prediction model. The results show that the variance component for the intercept is significantly different from zero. The conditional intraclass correlation for the intercept is 0.042.

EFFECT	VARIANCE COMPONENT	DEGREE OF FREEDOM	CHI-SQUARE	P-VALUE
Intercept	0.274	7	68.131	0.000
DESCSUM	0.037	7	30.699	0.000
AGE	0.000	7	13.239	0.066
COLLEGE	0.024	7	6.616	>0.500
Level-1 effect	6.228			

Table *II.T2: Final estimation of variance components for Equations *II.1

Interpretation: Equation *II.1 suggests that individuals who are ready to participate, who are young and have completed a college education are more likely to perceive the neutralization method of disposal positively. The metrics for both DESCSUM and AGE were centered around their respective grand means while COLLEGE was dummy-coded. Consequently, the intercept of 3.720 represents the expected NEUTRSUM score of the typical respondent who have not completed a college education. To predict the NEUTRSUM score of any given subject, it is necessary to use the subject's deviation scores on DESCSUM and AGE, but use 1 for having completed a college education and a 0 for not having completed a college education. To facilitate the application of Equation *II.2, Table *II.T3 provides the needed grand mean scores as well as for NEUTRSUM within the PART data subset.

VARIABLE	N	MEAN	STANDARD DEVIATION
NEUTRSUM	2,539	3.808	2.619
DESCSUM	2,538	4.864	1.460
AGE	2,503	44.451	15.629

Table *II.T3: Mean and standard deviation of predictor variables in Equation *II.1

The variance components presented in Table II.T2 show that the intercept has a variance component that is significantly different from zero. This suggests that there remains some unexplained residual variation of NEUTRSUM associated with the intercept from site to site beyond what is predicted in Equation *II.1. The conditional intraclass correlation of 0.042 further suggests that the residual variance for the intercept is not large but may make a noticeable difference, indicating the need to explore additional new site-level variables in order to predict NEUTRSUM.

Analysis II.B: ACTY data subset to predict NEUTRSUM:

When the ACTY data subset was analyzed through HLM to predict NEUTRSUM, no significant level-1 or level-2 predictor variable was found. Table *II.T4 shows the final estimation of variance components due to individual and site differences. The results show that the variance component for the intercept (level-2) is significantly different from zero. The conditional intraclass correlation for the intercept is 0.094.

EFFECT	VARIANCE COMPONENT	DEGREE OF FREEDOM	CHI-SQUARE	P-VALUE
Intercept	0.559	7	38.631	0.000
Level-1 effect	5.378			

Table *II.T4: Final estimation of variance components for NEUTRSUM using ACTY data subset

Interpretation: Given the level-1 and level-2 variables in the ACTY data subset for the subsample of individuals represented by this subset, we were unable to predict NEUTRSUM beyond the mean NEUTRSUM score. New and different predictor variables need to be identified and investigated in order to predict NEUTRSUM. The values of the estimated variance components suggest that variation in NEUTRSUM scores is due to both individual (level-1) difference and site (level-2) difference. This indicates that future investigations need to look into new predictor variables at both the individual and the site level. The intraclass correlation of 0.094 suggests that about 9 percent of the variance in NEUTRSUM can be attributed to site difference, rather than individual difference. This is substantial enough to warrant future investigations of site-related level-2 variables.

Discussion

This study addressed the following three research questions: (1) To what extent do respondents attribute specific diffusion characteristics with either the incineration or neutralization disposal technology? (2) To what extent do individual factors influence a respondent's *attributions toward the technologies?* (3) To what extent do community factors influence a respondent's *attributions toward the technologies?* The study findings provide some insight into each of these questions three questions.

To what extent do respondents attribute specific characteristics with either the incineration or neutralization disposal technology? This study provides an empirical basis for predicting the perceived technological attributes of disposal methods among people living near chemical weapons stockpile sites. The findings suggest that residents appear to perceive clear differences between the desirable characteristics of the two technologies (Table 3.0). In a relative comparison, the majority of positive technological attributes were more commonly associated with incineration. Given these findings, it is reasonable to suggest that incineration may lend itself more readily to public adoption than would neutralization. However, predicting the diffusion of either technology into the public is complicated by a number of factors.

The observed uncertainty among the residents implies that diffusion of the two technologies is not simply a matter of perceived attributes. An average of about one-third of residents indicated they *did not know* if given positive characteristics described either technology. Lack of knowledge concerning the technologies could pose a barrier to rapid diffusion of either technology. However, because we could not obtain a more precise measure of respondents' actual knowledge about the technologies, it is not clear if such knowledge would have a direct effect on technological adoption. Nonetheless, there was evidence that a small number of respondents had difficulty in assigning characteristics to either technology. The median percentage of respondents who did not attribute characteristics to *either* technology was about 14%. The median percentage of respondents who attributed characteristics to *both* technologies was about 16%. Diffusion of either technology could be impeded by residents' inability to differentiate among the methods with respect to various characteristics. The literature supports this assertion (Attewell, 1992). There is also the possibility that residents believe that a yet unknown technology may possess more desirable attributes than the two methods posed to them. However, a fairly small number of respondents overall indicated a degree of uncertainty and ambivalence concerning the two technologies.

The site level specificity of technology perceptions also should be considered in the prediction of technological diffusion. As evidenced by these findings, sites differed significantly with respect to individual perceptions of technology attributes. Although statistically significant, some differences between sites were small. There is some evidence to suggest that the site specificity of attributions may be a function of the technology currently in use at a site, the planned technology for a site, or lack of a chosen technology at a site. Five of the eight sites appear to be more ready to adopt incineration rather than neutralization. With the exception of the Pueblo site, each of these five sites is planning to use or are currently using the baseline incineration technology. The largest predisposition toward incineration is demonstrated among Tooele residents, who live near the only U.S. site that is currently incinerating chemical weapons. In contrast, the Pueblo site is part of the Assembled Chemical Weapons Assessment (ACWA) program that was created under Public Law 104-208. ACWA was created with specific intent of identifying ways other than incineration to dispose of chemical weapons. Blue Grass, one of the eight sites, demonstrated no strong predisposition toward either technology. Like Pueblo, the Blue Grass site is also included in the ACWA program. The remaining two sites demonstrated a small but significant predisposition toward the neutralization technology. These two sites are part of the Alternative Technologies and Approaches Program (ATAP). ATAP was designed to identify alternative technologies for disposing of unassembled chemical agents in bulk containers.

In each of the three scenarios, various programs have apparently had some influence on the public's perceptions toward technology. It is plausible that various events and decisions taking place at each site have influenced the respective "public conscience". The etiology of this influence is somewhat unclear but deserves further consideration and investigation. The technological disposal approach (incineration) of the four "baseline" sites appears to be extremely compatible with public perceptions. As mentioned previously, Tooele residents demonstrated the greatest predisposition toward incineration. This bodes well for incineration with respect to diffusion. Tooele residents' perceptions toward these disposal technologies appear to be more experientially founded than that of residents living near the other sites. The perceived efficacy of incineration appears to be enhanced by its actual and prolonged use. The literature suggests that institutionalized technologies are more readily accepted than newer technologies (Ganesh et al., 1997). That is, the public familiarity with various aspects of a technology is conducive to rapid diffusion.

The technological approach of the ATAP program also appears to be somewhat consistent with the residents' stance on technology. At both ATAP sites, the public is moderately predisposed toward neutralization. In contrast, the mission of the ACWA program seems to be directly incompatible with public perception. In Pueblo, the residents are not all adverse to the adoption of incineration. Pueblo residents are significantly more predisposed toward incineration than toward neutralization or an unknown technology. This suggests that diffusion of the incineration technology across the Pueblo population is likely to be more rapid than with any other technology. In Blue Grass, residents showed no strong disposition toward either technology or alternative technologies. Blue Grass residents demonstrated a more ambivalent attitude toward the technologies, suggesting that adoption of any disposal technology is likely to be slow. Given the respondents' perceptions toward the existing technologies, the acceptance of newer less proven technologies is highly unlikely. The diffusion of any alternative technology at these two sites would probably be slow if not idle. As mentioned previously, less familiar technologies typically diffuse at a slower rate than do better known technologies (Ganesh et al., 1997). A slowly diffusing technology could directly delay the schedule at the two sites, thus making it improbable that chemical demilitarization could be accomplished in a timely fashion.

To what extent do individual factors influence a respondent's technological attributions? Individual factors were found most predictive of attributions made toward incineration. In one model, perceptions toward incineration were influenced by one's perceived awareness and value of outreach, trust in the Army, perceived impact of site on community, intent to participate in the program, and income. In the other model, one's sex and one's perceptions toward media effects also influenced perceptions toward incineration. In the first model, one's perceptions toward the Army and outreach efforts directly affected one's perceptions toward incineration. As a person's trust in the Army increases, so do his or her positive attributions toward incineration. As a person's awareness and perceived value of public outreach efforts increases so does his or her positive attributions toward incineration. Additionally, individuals who perceive a *negative* impact of the site on the community, who are ready to participate in program activities, and who have a high level of income are more likely to perceive the incineration method of disposal positively. In the second model, many of the same trends were demonstrated. Positive perceptions toward incineration were associated with individuals who trust the Army, who perceive that the media have made them more trusting of weapons disposal activities, who are ready to participate, and who are male.

Past studies have indicated that the technological adoption is greatly affected by the public perceptions of the institutions or individuals responsible for implementing or overseeing the technology (Bradbury, 1994; Frewer and Sheperd, 1995; Parcel et al., 1995). In fact, such institutions or individuals are often called "change agents" because they can directly facilitate the diffusion process. The findings of this investigation echo these past studies. Perceptions toward incineration appear to be influenced by specific perceptions toward those responsible for instituting the technology. Institutional trust in both the Army and public outreach efforts represent decisive predictors of a population's perceptions toward disposal technologies. Contrary to popular belief, the public may be willing to accept a given technology so long as it trusts those individuals or groups responsible for designing, implementing, and evaluating the technology. The effects of institutional trust on perceptions of environmental risks and policy are well substantiated in the literature (Williams, Brown, and Greenberg, 1999). This study suggests that the Army has had an impact on people's perceptions toward incineration. Army outreach efforts may have helped people better understand characteristics of incineration technology, thus making the public more comfortable with technical decisions. Overall, these findings imply that the Army may facilitate the diffusion of the incineration technology by increasing public outreach efforts at the site and by further securing public trust. In this case, the Army represents an important "change agent" in the diffusion of the incineration technology.

The media represents an area in which the Army plays only a partial role in influencing public opinion. The effects of media on public opinion are widely debated. Many studies have provided evidence that communication sources directly influence the diffusion process (e.g., interpersonal and media-related) (Ferrence, 1996; Rogers, 1995b; Stiff, 1994). This study appears to support the findings of such studies. In this study, perceptions of information sources significantly influenced perceptions toward incineration. Approximately 42% of the respondents indicated that an information source had influenced his or her opinion about the chemical demilitarization program in general. Of the 42%, 33% indicated the information had them more trusting in the program, about 48% indicated the information made them less trusting, and about 19% indicated the information had no effect on his or her trust. Respondents who reported that the media or other information sources had made them more trusting of site disposal activities were more likely to associate positive characteristics with incineration than their less trusting counterparts. Of those respondents who reported being influenced by an information source, the three most frequently cited sources of information were newspapers (50.2%), television (18.9%), and personal contacts (7.7%) respectively. Community organizations (i.e., activist groups) were cited as influential by only 1% of respondents. Overall, newspapers influenced about 21% of the respondents' opinions concerning the program.

Although newspapers were most frequently sited as an influential source of information, the actual newspaper coverage of trust and technology issues was limited over the past year. A quantitative content analysis of the local print media at the stockpile sites revealed that about 15% of newspaper articles sampled at the sites focused on technological issues within the past year (Williams, Vallei, and Brown, 1999). Similarly, the vast majority (76.7%) of articles did not focus on trust issues. Furthermore, of those articles, only about 5% of them suggested that the Army or affiliated groups were not trustworthy (Williams, Vallei, and Brown, 1999). As corroborated by the findings, even small amounts of print media coverage concerning trust and technological issues can potentially affect perceptions toward incineration. Further investigation is needed to determine the specific mechanisms by which such coverage and other information sources influence technological perceptions. Additionally, it is not quite clear why community organizations (i.e., activist groups) were reportedly so ineffectual with respect to public opinion. Although such groups often have considerable influence in environmental policy, in this case they do not appear to appear to reflect or influence the views of the public at large. More research is necessary to examine the exact role of activist groups in the diffusion of environmental technologies.

The remaining factors influencing incineration perceptions include perceived impact of program, resident income, and participatory intent. Perceiving a negative impact from the site on one's community tended to increase one's positive attributions toward incineration. Additionally, wealthier residents reported significantly more positive attributions toward incineration than did their lower income counterparts. It is feasible to suggest that the mere presence of chemical agents is perceived as inherently negative by many site residents. Hence, incineration poses a quick solution to the problem. Additionally, higher income residents may have a personal stake in quickly ridding their community of the chemical weapons stockpile. For example, the disposal of these chemicals may be associated with increased property values or increased availability of land. There is also some indication that individuals predisposed toward incineration are ready to actively participate in the program. Overall, these personal factors may be influential in the adoption of the incineration technology. Other technology diffusion studies support this proposition (Ferrence, 1996). Such studies have found that variations is technology adoption may be specifically attributed to variations in personal factors including age, sex, residence, socioeconomic status and level of access to communications (Ferrence, 1996).

Unlike incineration, there was insufficient proof that individual factors influence variations in perceptions toward neutralization. One model found a statistically significant relationship between such perceptions and one's level of education, one's participatory intent, and one's age. However, these relationships were marginal and lack practical significance. The second model substantiates this position. In this model, the variance in neutralization perceptions is not sufficiently explained by the variables analyzed. Consequently, we do not know what would enhance or impede adoption of neutralization. As illustrated in the HLM analysis, there is a definite need to collect additional individual and site level data to explain variations in neutralization perceptions.

The observed disparities between perceptions of neutralization and incineration may be due in part to the relative maturity of each technology. Incineration arguably represents a more mature technology in terms of practice or application than does neutralization or variations thereof. Hence, the observed uncertainty and ambivalence toward neutralization may stem from the public's lack of familiarity with the technology. In terms of the Ganesh et al., model (1997), neutralization would likely be defined as a *discontinuous* innovation. That is, little is known about the core benefits of neutralization. However, given the historical use of incineration in environmental waste disposal, the public is more aware of its principal benefits. Hence, incineration would likely be deemed a *continuous* innovation. Obviously, the public learning curve is much steeper with newer or discontinuous technologies thus slowing their diffusion. An additional impediment to the diffusion of neutralization and alternative technologies is the clear existence of a technical standard, incineration (Ganesh et al., 1997). As a baseline technology, incineration represents a technical standard, whereas other methods (e.g., neutralization) represent conflicting technologies. For conflicting technologies to be readily diffused they must demonstrate a relative advantage over the existing technology. To date, performance assessments of neutralization and alternative technologies have not yielded empirical evidence of such an advantage over incineration (National Research Council, 1999). Consequently, it is likely that the diffusion of alternative disposal technologies would be much slower than that of incineration.

To what extent is a respondent's technological attributions influenced by his or her local condition? Sites differed significantly with respect to perceptions toward the disposal technologies. Other studies have found that geographic and economic similarities are important predictors of technological adoption in a population (Ganesh et al., 1997). Although there are significant differences in technological perceptions across sites, the effects of site level variables on such perceptions remains inconclusive. As indicated in the HLM analyses, there is a lack of statistical evidence that the selected community level factors influenced individual perceptions toward the technologies. However, the variance components for each of the models were significant. This indicates that a significant amount of the variation in such perceptions can be explained by site level factors However, these factors are yet unknown, and thus were not tested in the current model. There are definite site level differences in perceived attributions, the magnitude of which varied with each model.

As suggested in the HLM analyses, additional site level data is needed to better understand the origins of and variations in disposal technology perceptions. The Ganesh et al. (1997) conceptual model could be used to guide such an investigation. As discussed in the literature review, this model proposes a way to examine the effects of geographic similarity, cultural similarity, time lag, innovation type, and technical standards on diffusion. The local outreach offices could make a substantial contribution by identifying and collecting these types of community level data concerning the sites. This information could be periodically updated and investigated longitudinally. Such efforts would help capture the unique local conditions that influence technological acceptance.

.

References

1. Arnold, C. L. (1992). An introduction to hierarchical linear models. *Measurement and Evaluation in Counseling and Development, 25,* 59-90.

2. Attewell, P. (1992). Technology diffusion and organizational learning: The case of business computing. *Organization Science, 3,* 1-19.

3. Baker, R. (1996). Nobody's talking. The method isn't the issue. Response rates are down period. *Marketing Research, 8*(1), 22-24.

4. Binney, S. E., Mason, R., Martsolf, S. W., and Detweiler, J. H. (1996). Credibility, public trust, and the transport of radioactive waste through local communities. *Environment and Behavior, 28,* 283-301.

5. Blackwood Jr., M. E. (Jul/Aug 1999). Ridding the United States of chemical warfare material. *Society, 36*(5), 63+.

6. Bradbury, J. A. (1994). Risk communication in environmental restoration programs. *Risk Analysis, 14,* 357-363.

7. Cohen, N. (1995). Technical assistance for citizen participation: A case study of New York City's environmental planning process. *American Review of Public Administration, 25*(2), 119-135.

8. Davis, J. A. and Smith, T. W. (1992). *The NORC General Social Survey: A User's Guide*. Newsbury Park: Sage.

9. Dearing, J. W., Rogers, E. M., Meyer, G., Casey, M. K., Rao, N., Campo, S., and Henderson, G. (1996). Social marketing and diffusion-based strategies for communicating with unique populations: HIV prevention in San Francisco. *Journal of Health Communication, 1*, 343-363.

10. Desario, J. and Langton, S. (1987). Citizen participation and technocracy. *Citizen Participation in Public Decision Making*. Westport, CT: Greenwood Press.

11. Eagly, A. H., and Chaiken, S. (1993). *The psychology of attitudes.* Fort Worth, TX: Harcourt Brace Jovanovich.

12. Feenberg, A. (1990). The ambivalence of technology. *Sociological Perspectives, 33,* 35-50.

Ferrence, R. (1996). Using diffusion theory in health promotion: The case of tobacco. *Canadian Journal of Public Health, 87* (Suppl. 2), 24-27.

13. Freudenberg, W. R., and Pastor, S. K. (1992). Public responses to technological risks: Toward a sociological perspective. *Sociological Quarterly, 33,* 389-412.

14. Frewer LJ, Shepard R. (1995). Attributing information to different sources: Effects on the perceived qualities of information, on the perceived relevance of information and effects on attitude formation. *Public Understanding Science 3,* 385-401.

15. Ganesh, J., Kumar, V., and Subramaniam, V. (1997). Learning effect in multinational diffusion of consumer durables: An exploratory investigation. *Journal of the Academy of Marketing Science, 25,* 214-228.

16. Glanz, K., Lewis, F. M. and Rimer, B. K. (1990). *Health Behavior and Health Education*. San Francisco, CA: Jossey-Bass.

17. Greer, A. N. (1995). The shape of resistance . . . the shapers of change. *Joint Commission Journal on Quality Improvement, 21,* 328-332,

18. Hox, J. J. and de Leeuw, E. D. (1994). A comparison of nonresponse in mail, telephone, and face-to-face surveys. *Quality and Quantity, 28,* 329-344.

19. Jeffres, L., and Atkin, D. (1996). Predicting use of technologies for communication and consumer needs. *Journal of Broadcasting and Electronic Media, 40,* 318-330.

20. Kemp, R. (1990). Why not in my backyard? A radical interpretation of public opposition to the deep disposal of radioactive waste in the United Kingdom. *Environment and Planning, 22,* 1239-1258.

21. Kristal, A. R., White, E., Davis, J. R., Corycell, G., Raghunathan, T., Kinne, S., and Lin, T. K. (1993). Effects of enhanced calling efforts on response rates, estimates of health behavior, and costs in a telephone health survey using random-digit dialing. *Public Health Reports, 108*(3), 372-379.

22. Kunreuther, H., Easterling, D., Desvousges, W., and Slovic, P. (1990). Public attitudes toward siting a high-level nuclear waste repository in Nevada. *Risk Analysis, 10*(4), 469-484.

23. Kweit, M. G. and Kweit, R. W. (1987). *The politics of policy analysis: The role of citizen participation in analytic decision making.* In J. De Sario and S. Langton, *Citizen participation in public decision making.* New York: Greenwood Press.

24. Lidskog, R. (1997). From conflict to communication? Public participation and critical communication as a solution to siting conflicts in planning for hazardous waste. *Planning Practice and Research, 12*(3), 239+.

25. Luevano, P. (1994). *Response rates in the national election studies*. Technical Report No. 44, National Elections Studies.

26. Michaelson, A. G. (1993). The development of a scientific specialty as diffusion through social relations: The case of role analysis. *Social Networks, 15,* 217-236.

27. National Research Council (1999). *"Review and Evaluation of Alternative Technologies for Demilitarization of Assembled Chemical Weapons"* Authored by the NRC Committee on the Review and Evaluation of Alternative Technologies for Demilitarization of Assembled Chemical Weapons.

28. Oldenburg, B., Hardcastle, D. M., and Kok, G. (1997). *Diffusion of innovations.* In K. Glanz, F. M. Lewis, B. K. Rimer (Eds.), *Health behavior and health education* (2nd ed., pp. 270-286). San Francisco: Jossey-Bass.

29. Oldendick, R. W. and Link, M. W. (1994). The answering machine generation. Who are they and what problem do they pose for survey research? *Public Opinion Quarterly, 58*, 264-273.

30. Oldendick, R. W., Bishop, G. F., Sorenson, S. B., and Tuchfarberber, A. J. (1988). A comparison of the Kish and last birthday methods of respondent selection in telephone surveys. *Journal of Official Statistics, 4,* 307-318.

31. O'Rourke, D. and Blair, J. (1983). Improving random respondent selection in telephone surveys. *Journal of Marketing Research, 20,* 428-432.

32. Parcel, G. S., O'Hara-Tompkins, N. M., Harrist, R. B., Basen-Enguist, K. M., McCormick, L. K., Gottlieb, N. H., and Eriksen, M. P. (1995). Diffusion of an effective tobacco prevention program: Part II. Evaluation of the adoption phase. *Health Education Research, 10,* 297-307.

33. Paulussen, T., Kok, G., Schaalma, H., and Parcel, G. S. (1995). Diffusion of AIDS curricula among Dutch secondary school teachers. *Health Education Quarterly, 22,* 227-243.

34. Peters, R. G., Covello, V. T., and McCallum, D. B. (1997). The Determinants of trust and credibility in environmental risk communities: An empirical study. *Risk Analysis, 17(1)*, 43-54.

35. Reagan, J. (1991). Technology adoption: Is satisfaction the best predictor. *Journalism Quarterly, 8,* 325-332.

36. Reagan, J., Pinkleton, B., Aaronson, D. and Ramo, E. (1995). Differentiating telephone surveys from telemarketing to increase response rates. *Communication Research Reports*, *12 (2*), 170-177.

37. Rogers, E. M. (1995a). *Diffusion of innovations* (4th ed.). New York: Free.

38. Rogers, E. M. (1995b). Lessons for guidelines from the diffusion of innovations. *Joint Commission Journal on Quality Improvement, 21,* 324-328.

39. Salter, R. (1999). *Statement for the Record of Russell Salter, Director, Chemical and Radiological Preparedness Division, Federal Emergency Management Agency before the Subcommittee on Government Management, Information and Technology of the Committee on Government Reform U.S. House of Representatives August 16, 1999.*

40. Shepherd, A. and Bowler, C. (1997). Providing balanced risk information in surveys used as citizen participation mechanisms. *Society and Natural Resources*, *40*(6), 107+.

41. Shaperman, J., and Backer, T. E. (1995). The role of knowledge utilization in adopting innovations from academic medical centers. *Hospital and Health Services Administration, 40,* 401-413.

42. Smith, T. W. (1995). Trends in non-response rates. *International Journal of Public Opinion Research*, *7*(2), 157-171.

43. Soden, D. L. (1995). Trust in sources of technical information. *Journal of Environmental Education, 26,* 16-21.

44. Sparkes, V., and Kang, N. (1986). Public reactions to cable television: Time in the diffusion process. *Journal of Broadcasting, 30,* 213-229.

45. Stiff, J. B. (1994). *Persuasive communication.* NY: Guilford.

46. U.S. Bureau of the Census. (Internet Release Date: March 12, 1999). County Population Estimates and Demographic Components of Population Change: Annual Time Series, July 1, 1990 to July 1, 1998. http://www.census.gov

47. United States Library of Congress. (1993). Convention on the prohibition of the development, production, stockpiling and use of chemical weapons and on their destruction. Treaty Document 103-21. Retrieved form the World Wide Web on 11-29-99. Web page: http://www.state/gov/www/global/arms/factsheet/wmd/cw/cwcfs.html.

48. Whitlark, D. and Geurts, M. (1998). Phone surveys. How well do respondents represent average Americans? *Marketing Research*, *10*(3), 13-17.

49. Williams, B. L., Brown, S., and Greenberg, M. (1999). Determinants of trust perceptions among residents surrounding the Savannah River Nuclear Weapons Site. *Environment and Behavior*, *31*, 354-371.

50. Williams, B. L., Vallei, A., and Brown, S. (1999). Content analysis of print media coverage of the U.S. Army's chemical demilitarization program of eight Department of defense sites. Manuscript submitted for publication.

Appendices

Appendix A
Final Survey Objectives by Rank

OBJECTIVES	
1.	Perceived community health risks associated with the use of potential, proposed, or existing technology used for disposal of chemical agent in community.
2.	The extent to which the public is familiar with a site's existence, location, stockpiled chemical agent, and storage and/or disposal activities or plans.
3.	Public's understanding of potential, proposed or existing technology used for disposal of chemical agent at local site.
4.	Public understanding and practice of emergency response procedures among residents living in Emergency Response Zones.
5.	Perceived community health risks (to the public and on-site personnel) associated with storage of chemical agent in community.
6.	Degree of public acceptance (e.g., reasons for acceptance or lack of acceptance) of potential, proposed or existing technology used for disposal of chemical agent at local site.
7.	The extent to which the public trusts the Army to look out for the public's general welfare (e.g., providing truthful and timely information).
8.	The extent to which the public trusts the Army and related contractors to achieve the goals of the Chemical Demilitarization Program.
9.	Degree of public trust in all those who oversee the Chemical Demilitarization Program including federal And state regulators and independent oversight groups (e.g., National Research Council).
10.	Public's intention to participate in program decision-making process and the public's perceived barriers to and benefits of such participation.
11.	Perceptions toward the site's overall impact on the local environment.
12.	Perceived impact of and awareness of outreach activities (e.g., information and involvement activities) undertaken at local site.
13.	The extent to which the public believes the site has positively or negatively influenced their local community (i.e., economic impact, impact on community image, etc.).
14.	Utilization of and perceptions toward communication sources (i.e., media) among residents living near site.
15.	Public awareness of the non-stockpile chemical materiel program scope, responsibilities, local material location, and any local issues pertaining to the non-stockpile chemical materiel program (e.g., buried/recovered chemical warfare materiel).
16.	Perceptions toward the future use of on-site land for other purposes (e.g., industry, recreation, etc.).

Appendix B
List of all Variables Analyzed

Level 1 Variables	Description
Emprsum	Sum on Emergency Preparedness subscale
Pgm7	Item: "The media has strongly influenced my personal opinion about the site."
Pgmsum	Sum on Outreach Awareness subscale
Trustsum	Sum on Trust of Army Activities subscale
Impact	Positive or negative effect of site on the community
Electmed	Reported that television, radio, or computer is the best way to be kept up to date about chemical weapons disposal activities.
Written	Reported that the newspaper or other written media is the best way to be kept up to date about chemical weapons disposal activities
Indiv	Reported that individuals such as personal contacts, professionals, or community spokespersons are the best way to be kept up to date about chemical weapons disposal activities
Group	Reported that employer, government agencies, religious groups, community organizations, the local outreach office, or public meetings are the best way to be kept up to date about chemical weapons disposal activities
Hear1	Respondent reported that something specific influenced opinion about chemical weapons disposal issues
Impelect	Respondent reported that television or radio influenced opinion about chemical weapons disposal issues
Impwrit	Respondent reported that newspaper or other written media influenced opinion about chemical weapons disposal issues
Impindiv	Respondent reported that personal contacts, professionals, or community spokespersons influenced opinion about chemical weapons disposal issues
Impgroup	Respondent reported that employer, government agencies, religious groups, community organizations, the local outreach office, or public meetings influenced opinion about chemical weapons disposal issues
Intrust	"Did this activity make you more or less trusting about chemical weapons disposal related activities?"
Descsum	Sum on Readiness to Participate subscale
Actysum	Sum on Risk Perception subscale
Incinsum	Respondent's perception of the incineration method of chemical weapons disposal
Neutrsum	Respondent's perception of the neutralization method of chemical weapons disposal
Partsum	Sum on Participation subscale
Age	Age of respondent
Sex	Male or Female
Black	Reported race as Black
White	Reported race as White
Hispanic	Reported race as Hispanic
Nativeam	Reported race as Native American
Highsch	Highest degree is high school or below
College	Highest degree is college and beyond
Fulltime	Works full time
Parttime	Works part time
Unemploy	Unemployed including disabled and homemakers
Retired	Retired
Manager	Reported occupation as managerial, professional specialty, or education
Technica	Reported occupation as technical, sales, or administrative support

Level 1 Variables	Description
Service	Reported occupation as service or protective services
Laborer	Reported occupation as farming/fishing/forestry, manufacturing, laborer, or transportation
Military	Reported occupation as military or governmental
Curremp	Respondent is current site employee
Prevemp	Respondent was previous site employee
Famcurr	Family member is current site employee
Famprev	Family member was previous site employee
Dist	Perceived distance from site
Protest	Individuals self-reported as practicing a Protestant religion
Catholic	Individuals self-reported as practicing Catholicism
Latterda	Individuals self-reported as being Latter Day Saints
Otherrel	Individuals self-reported as practicing another religion
Norelig	Individuals self-reported as practicing no religion
Income	Income Level
Famsize	Number in household (inclusive)
Partic	Participated in survey past year
Tlive	Years lived in town

Level 2 Variables	Description
w_avg1	Weighted average of pupil-teacher ratio per site
w_avg2	Weighted average of population density
w_avg3	Weighted average of percent population change
w_avg4	Weighted average of percent population change (over age 65)
w_avg5	Weighted average of percent birth rate
w_avg6	Weighted average of age adjusted death rate
w_avg7	Weighted average of crude death rate
w_avg8	Weighted average of violent crime rate
w_avg9	Weighted average of percentage of 1990 population level 1 literacy rate
w_avg10	Weighted average of percentage of students designated as free lunch eligible
pop96	Site population in 1996
m_pop96	Mean county population per site in 1996
n_cnty	Number of counties in analysis per site
a_popov	Percent of the population in poverty
a_tstud	Percentage of the population who are students in K through 12
a_test	Business establishments per population
med_inc	Median Income
n_groups	Number of activist groups
budget	ORO FY 1999 budget
fte	ORO Full time employees
mission	Site's mission after Demilitarization (No Longer Operational or Continued Mission)
colleges	Number of year colleges near site
governor	Governor party control
senate	Senate party control
sthouse	Statehouse party control
voters	Total registered voters
turnout	General election turnout average
st_act	Activist groups per population

Appendix C
Regression Statistics For The OLS Regression Equivalence Of The Level-1 Prediction Equations

Dependent Variable: INCINSUM

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.457(a)	.209	.207	2.4423

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3309.376	5	661.875	110.963	.000(a)
	Residual	12550.035	2104	5.965		
	Total	15859.410	2109			

Dependent Variable: INCINSUM

Coefficients(a)

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Model		B	Std. Error	Beta		
1	(Constant)	.997	.350		2.846	.004
	PGMSUM	5.686E-02	.009	.153	6.333	.000
	TRUSTSUM	5.584E-02	.007	.190	7.911	.000
	IMPACT	-.493	.066	-.160	-7.497	.000
	DESCSUM	.303	.039	.159	7.858	.000
	INCOME	3.946E-02	.031	.025	1.268	.205

Regression: Acty subset using Incinsum as DV

Dependent Variable: INCINSUM

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.497(a)	.247	.244	2.5160

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2103.436	4	525.859	83.074	.000(a)
	Residual	6412.318	1013	6.330		
	Total	8515.753	1017			

Coefficients(a)

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Model		B	Std. Error	Beta		
1	(Constant)	2.582	.490		5.273	.000
	TRUSTSUM	6.368E-02	.010	.212	6.524	.000
	INTRUST	.600	.106	.186	5.668	.000
	DESCSUM	.460	.059	.218	7.805	.000
	Gender	-1.008	.160	-.173	-6.279	.000

Regression: Part Subset using Neutrsum as DV (1)

Dependent Variable: NEUTRSUM

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.230(a)	.053	.052	2.5623

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	825.206	3	275.069	41.898	.000(a)
	Residual	14804.425	2255	6.565		
	Total	15629.632	2258			

Coefficients(a)

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Model		B	Std. Error	Beta		
1	(Constant)	4.644	.284		16.380	.000
	DESCSUM	.165	.037	.091	4.401	.000
	Age	-3.642E-02	.004	-.215	-10.400	.000
	Income	3.768E-03	.032	.002	.119	.905